

Supplementary Table S1. Conventional MRI scan parameters.

<b>MR sequences</b>	<b>TE (ms)</b>	<b>TR (ms)</b>	<b>Thickness/Space (mm)</b>	<b>FOV (cm)</b>	<b>Matrix</b>	<b>Nex</b>	<b>Slice</b>
Ax T2WI	Minimum	5000	5.0/1.0	24×24	288×288	1	22
Ax T2 FLAIR	140	6200	5.0/1.0	24×24	256×256	1	22
Ax T1WI	24	3002.7	5.0/1.0	24×24	288×256	1	22
Ax DWI b=1000	Minimum	5000	5.0/1.0	24×24	128×128	2	44
3D T1 GRE	Minimum	2100	1.0/0.0	25×25	256×256	1	188
3D T1 CE GRE	Minimum	2100	1.0/0.0	25×25	256×256	1	188

Note: TE, Echo Time; TR, Repetition Time; FOV, Field of View; NEX, Number of Excitations; FSE, Fast Spin Echo; GRE, Gradient Echo; FLAIR: Fluid Attenuated Inversion Recovery; DWI, Diffusion-Weighted Imaging.

Supplementary Table S2. Features differences from mono-modal MRI between IDH-mutant group and IDH-wildtype group.

Variable	IDH-mutant N = 56	IDH-wildtype N = 60	Z/t	<i>p</i> value
<b>Conventional MRI</b>				
Sex, n (%)			0.028	0.868
female	27 (48.2%)	28 (46.7%)		
male	29 (51.8%)	32 (53.3%)		
Age, Median (IQR)	44.5 (34, 54)	58.5 (48, 65)	-13.149	<0.001
Tumor location, n (%)			12.532	0.006
Frontal lobe	34 (60.7%)	19 (31.7%)		
Parietal lobe	7 (12.5%)	13 (21.7%)		
Temporal lobe	8 (14.3%)	22 (36.7%)		
Other	7(12.5%)	6 (10%)		
Enhancement degree, n (%)			43.58	<0.001
marked	14 (25%)	46 (76.6%)		
mild	6 (10.7%)	10 (16.7%)		
no	36 (64.2%)	4 (6.67%)		
Necrosis or cyst, n (%)			33.578	<0.001
no	38 (67.8%)	9 (15%)		
yes	18 (32.1%)	51 (85%)		
Nonenhancing part, n (%)			8.148	0.004
no	9 (16.1%)	24 (40%)		
yes	47 (83.9%)	36 (60%)		
Peritumoral edema, n (%)			28.75	<0.001
0	34(60.7%)	8(13.3%)		
1	15(26.8%)	30(50%)		

2	7(12.5%)	22(36.7%)		
<b>MRS metabolites ratio</b>				
NAA/Cr	1.36 (1.058, 1.75)	0.93 (0.576, 1.195)	-4.818	<0.001
Cho/Cr	1.795 (1.433, 3.208)	2.985 (1.79, 3.982)	-2.564	0.01
Cho/NAA	1.475 (0.996, 2.297)	2.99 (2.09, 5.035)	-4.058	<0.001
<b>DTI histogram features</b>				
FA_10Percentile	0.072 (0.058, 0.088)	0.076 (0.058, 0.093)	-1.138	0.255
FA_90Percentile	0.262 ± 0.056	0.307 ± 0.057	-4.259	<0.001
FA_Energy	270.711 (82.969, 1331.411)	190.468 (95.888, 2497.332)	-0.558	0.577
FA_Entropy	0 (0, 0)	0 (0, 0)	-1.865	0.062
FA_InterquartileRange	0.094 (0.073, 0.112)	0.116 (0.097, 0.142)	-4.039	<0.001
FA_Kurtosis	5.381 (4.146, 7.562)	4.221 (3.495, 5.925)	-2.646	0.008
FA_Maximum	0.618 ± 0.166	0.704 ± 0.165	-2.802	0.006
FA_Mean	0.153 (0.132, 0.18)	0.181 (0.16, 0.2)	-3.895	<0.001
FA_MeanAbsoluteDeviation	0.062 ± 0.016	0.072 ± 0.017	-3.486	<0.001
FA_Median	0.135 (0.112, 0.16)	0.166 (0.145, 0.185)	-4.293	<0.001
FA_Minimum	0.022 (0.016, 0.031)	0.02 (0.015, 0.028)	-1.124	0.261
FA_Range	0.592 ± 0.176	0.681 ± 0.17	-2.765	0.007
FA_RobustMeanAbsoluteDeviation	0.041 ± 0.013	0.05 ± 0.013	-3.947	<0.001
FA_RootMeanSquared	0.174 (0.15, 0.205)	0.207 (0.183, 0.223)	-4.050	<0.001
FA_Skewness	1.381 (0.964, 1.864)	0.923 (0.686, 1.311)	-3.895	<0.001
FA_TotalEnergy	350.876 (100.834, 1551.878)	1261.881 (124.23, 3047.885)	-1.464	0.143
FA_Uniformity	1 (1, 1)	1 (1, 1)	-1.320	0.187

FA_Variance	0.008 (0.005, 0.011)	0.01 (0.007, 0.016)	-2.586	0.010
MD_10Percentile	1042.686 ± 165.194	971.811 ± 169.221	2.280	0.024
MD_90Percentile	1741.727 (1537.543, 1970.405)	1825.906 (1530.627, 2130.594)	-0.890	0.374
MD_Energy	25500760758.029 (6250367857.747, 114223541307.714)	15457335828 (6374650537.833, 99821830238.82)	-0.171	0.864
MD_Entropy	5.282 ± 0.551	5.502 ± 0.525	-2.201	0.030
MD_InterquartileRange	322.357 (250.221, 480.62)	409.755 (296.447, 531.316)	-1.995	0.046
MD_Kurtosis	3.422 (2.691, 4.47)	3.785 (2.692, 4.983)	-0.829	0.407
MD_Maximum	2631.202 (2161.414, 3032.256)	3037.228 (2445.871, 3480.182)	-2.359	0.018
MD_Mean	1410.234 ± 207.235	1394.653 ± 300.788	0.323	0.748
MD_MeanAbsoluteDeviation	198.856 (150.652, 278.815)	251.439 (206.14, 345.225)	-2.635	0.008
MD_Median	1337.95 (1240.557, 1537.193)	1357.409 (1132.607, 1513.879)	-0.901	0.368
MD_Minimum	556.049 (281.594, 712.756)	548.99 (346.94, 637.015)	-0.633	0.527
MD_Range	2200.009 ± 973.774	2546.465 ± 882.268	-2.010	0.047
MD_RobustMeanAbsoluteDeviation	135.604 (103.85, 202.288)	172.67 (132.662, 239.533)	-2.182	0.029
MD_RootMeanSquared	1390.62 (1286.763, 1584.484)	1454.452 (1241.13, 1608.724)	-0.127	0.899
MD_Skewness	0.451 (-0.202, 0.662)	0.725 (0.308, 1.249)	-3.193	0.001

MD_TotalEnergy	29969071622.907 (6268349405.238, 137030570190.491)	58516072087.423 (8565893235.055, 152838922350.748)	-0.823	0.410
MD_Uniformity	0.031 (0.025, 0.04)	0.026 (0.021, 0.035)	-1.961	0.050
MD_Variance	66104.613 (40389.001, 123171.297)	110100.638 (74677.166, 230287.738)	-2.807	0.005
<b>DTI clinical parameters</b>				
FA2d_Maximum	0.158 (0.121, 0.221)	0.256 (0.205, 0.309)	-4.961	<0.001
FA2d_Maximum_ratio	0.302 (0.244, 0.406)	0.465 (0.361, 0.66)	-4.619	<0.001
FA2d_Mean	0.104 (0.084, 0.134)	0.176 (0.143, 0.215)	-5.387	<0.001
FA2d_Mean_ratio	0.266 (0.2, 0.361)	0.423 (0.31, 0.538)	-4.398	<0.001
FA2d_Median	0.099 (0.078, 0.125)	0.166 (0.135, 0.204)	-5.160	<0.001
FA2d_Median_ratio	0.263 (0.19, 0.337)	0.434 (0.308, 0.507)	-4.337	<0.001
FA2d_Minimum	0.059 (0.046, 0.075)	0.096 (0.072, 0.141)	-4.793	<0.001
FA2d_Minimum_ratio	0.244 (0.143, 0.411)	0.384 (0.228, 0.517)	-2.553	0.011
MD2d_Maximum	1561.38 (1404.408, 1791.777)	1365.195 (1130.26, 1598.15)	-3.475	<0.001
MD2d_Maximum_ratio	1.683 (1.467, 2.041)	1.555 (1.282, 1.88)	-2.105	0.035
MD2d_Mean	1407.612 ± 295.907	1129.315 ± 220.195	5.772	<0.001
MD2d_Mean_ratio	1.732 ± 0.444	1.431 ± 0.322	4.209	<0.001
MD2d_Median	1407.771 ± 316.357	1126.54 ± 231.221	5.492	<0.001
MD2d_Median_ratio	1.74 ± 0.473	1.427 ± 0.337	4.080	<0.001
MD2d_Minimum	1201.092 ± 284.493	916.584 ± 205.267	6.139	<0.001
MD2d_Minimum_ratio	1.62 (1.364, 1.894)	1.27 (1.112, 1.446)	-4.613	<0.001

Note: IDH, isocitrate dehydrogenase; MRS, magnetic resonance spectroscopy; Cho, Choline; NAA, N-acetyl-aspartate; Cr, Creatine; DTI, diffusion tensor imaging; FA, fractional anisotropy; MD, mean diffusivity.

Supplementary Table S3. Logistic regression results for prediction IDH status based on features from mono-modal MRI model.

	Variable	OR with CI	SE	Wald	<i>p</i> value
<b>Conventional MRI</b>	enhancement degree	2.88 (1.54-5.40)	0.321	10.912	<0.001
	necrosis/cyst	4.63 (1.60-13.44)	0.543	7.957	0.005
<b><sup>1</sup>H-MRS</b>	Cho/NAA	1.53 (1.16-2.01)	0.14	9.315	0.002
	NAA/Cr	0.82(0.47-1.41)	0.279	0.523	0.469
<b>DTI histogram</b>	FA-Maximum	2.08(0.98-4.41)	0.383	3.652	0.056
	FA-Median	1.245(0.29-5.36)	0.743	0.089	0.77
	FA-RootMeanSquared	1.05(0.25-4.34)	0.725	0.004	0.95
	FA-Skewness	0.39(0.18-0.85)	0.395	5.627	0.018
	MD-Entropy	1.72(1.03-2.87)	0.261	4.296	0.038
	MD-Skewness	1.51(0.91-2.51)	0.259	2.517	0.113
	FA <sub>mean</sub>	2.82(1.61-4.96)	0.288	12.972	<0.001
	MD <sub>mean</sub>	0.83(0.30-2.36)	-0.182	0.118	0.731
<b>Conventional DTI</b>	MD <sub>min</sub>	0.32(0.11-0.95)	-1.131	4.225	0.040

Supplementary Table S4. Features differences from mono-modal MRI between MGMT-methylated group and MGMT-unmethylated group.

Variable	methylated, N = 37	unmethylated, N = 17	Z/t	<i>p</i> value
<b>Conventional MRI</b>				
Sex, n (%)			0.440	0.507
Female	16 (43.2%)	9 (52.9%)	1.229	0.222
male	21 (56.8%)	8 (47.1%)		
Age, Median (IQR)	62(51, 68)	52(48, 63)	-1.23	0.219
Tumor location, n (%)				1
Frontal lobe	12(32.4%)	6(35.3%)		
Parietal lobe	6(16.2%)	2(11.8%)		
Temporal lobe	15(40.5%)	7(41.2%)		
Other	4(10.8%)	2(11.8%)		
Enhancement degree, n (%)				0.547
marked	28 (75.7%)	15 (88.2%)		
mild	7 (18.9%)	1 (5.9%)		
no	2 (5.4%)	1 (5.9%)		
Necrosis or cyst, n (%)				0.696
no	5 (13.5%)	3 (17.6%)		
yes	32 (86.5%)	14 (82.4%)		
Nonenhancing part, n (%)			0.032	0.857
no	14 (37.8%)	6 (35.2%)		
yes	23 (62.2%)	11(64.7%)		
Peritumoral edema, n (%)				0.915
0	4(10.8%)	2(11.8%)		
1	20(54.1%)	8(47.1%)		

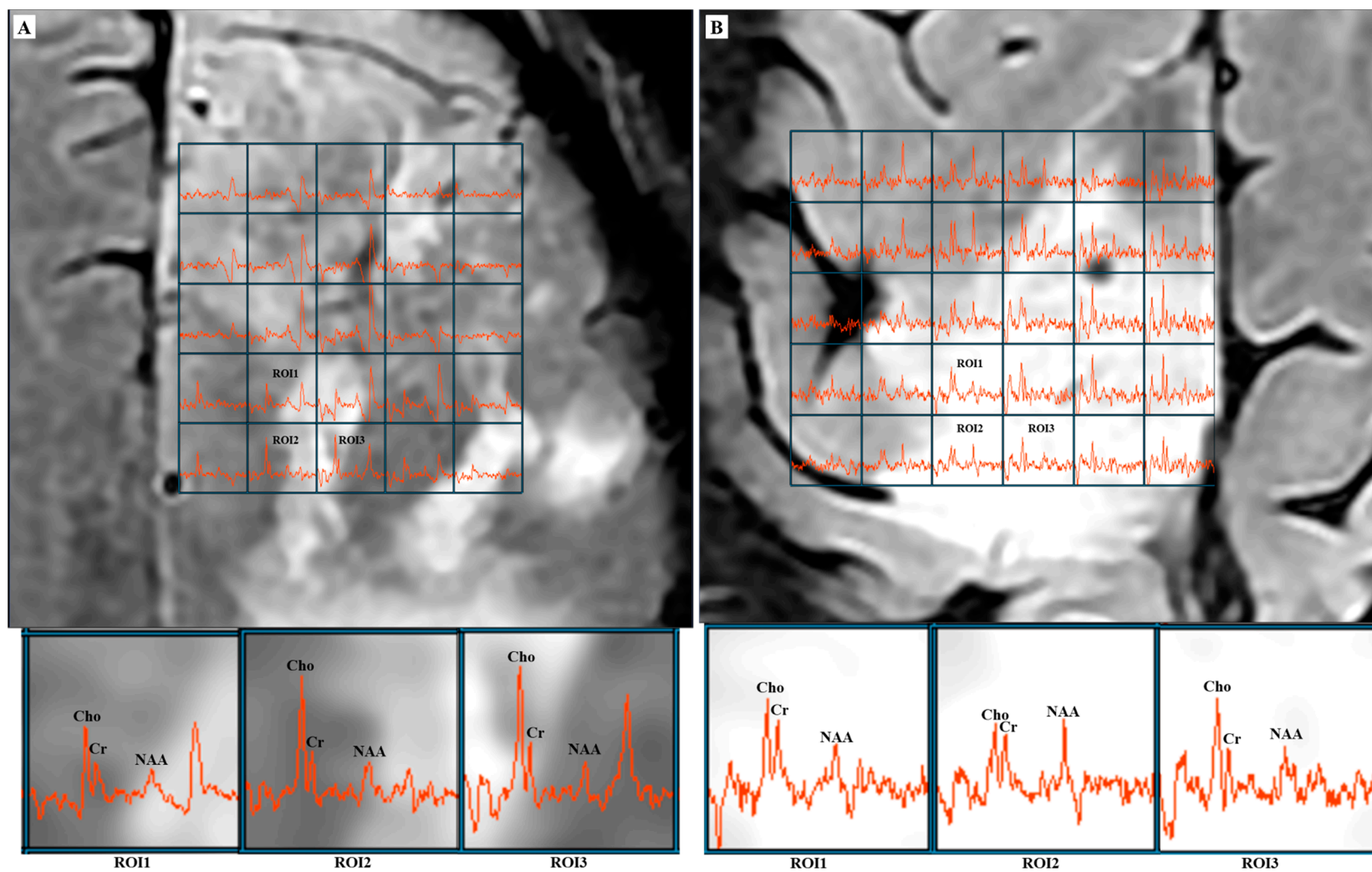
2	13(35.1%)	7(41.2%)		
<b>MRS metabolites ratio</b>				
NAA/Cr	1.03 (0.736, 1.43)	0.72 (0.522, 0.98)	-2.468	0.014
Cho/Cr	3.14 (2.06, 4.73)	2.2 (1.69, 3)	-1.891	0.060
Cho/NAA	2.85 (2.06, 5.11)	3.14 (2.14, 4.9)	-0.074	0.941
<b>DTI histogram features</b>				
FA_10Percentile	0.086 (0.072, 0.092)	0.075 (0.057, 0.087)	-1.425	0.154
FA_90Percentile	0.315 ± 0.05	0.295 ± 0.05	1.319	0.193
FA_Energy	3814.293 (1547.159, 5444.654)	1297.514 (199.005, 4566.673)	-1.872	0.061
FA_Entropy	0.001 (0, 0.006)	0.002 (0, 3.359)	-0.849	0.396
FA_InterquartileRange	0.12 ± 0.026	0.117 ± 0.036	0.341	0.734
FA_Kurtosis	4.561 (3.719, 6.804)	5.266 (4.485, 6.45)	-0.717	0.473
FA_Maximum	0.883 (0.752, 0.978)	0.778 (0.709, 0.89)	-1.760	0.078
FA_Mean	0.186 (0.173, 0.206)	0.179 (0.146, 0.191)	-1.946	0.052
FA_MeanAbsoluteDeviation	0.073 ± 0.013	0.072 ± 0.019	0.205	0.840
FA_Median	0.172 (0.16, 0.197)	0.162 (0.125, 0.174)	-2.226	0.026
FA_Minimum	0.02 (0.015, 0.03)	0.019 (0.015, 0.023)	-0.773	0.440
FA_Range	0.858 (0.753, 0.975)	0.756 (0.7, 0.869)	-1.741	0.082
FA_RobustMeanAbsoluteDeviation	0.05 ± 0.01	0.049 ± 0.015	0.229	0.820
FA_RootMeanSquared	0.209 (0.195, 0.227)	0.207 (0.179, 0.213)	-1.872	0.063
FA_Skewness	1.082 ± 0.48	1.239 ± 0.421	-1.60	0.251
FA_TotalEnergy	3814.293 (2238.243, 5444.654)	2968.95 (1297.514, 4566.673)	-1.574	0.116
FA_Uniformity	1 (0.999, 1)	1 (0.131, 1)	-0.887	0.375



FA_Variance	0.009 (0.007, 0.012)	0.011 (0.009, 5.79)	-1.481	0.139
MD_10Percentile	977.89 ± 176.449	989.934 ± 146.312	-0.245	0.807
MD_90Percentile	1887.749 ± 526.035	1906.492 ± 410.802	-0.130	0.897
MD_Energy	10780356889.835 (7118404022, 94131997089.284)	19568940063 (4459202779.942, 149328791522.544)	-0.473	0.473
MD_Entropy	5.477 ± 0.561	5.594 ± 0.457	-0.755	0.453
MD_InterquartileRange	409.183 (297.716, 517.113)	431.75 (369.75, 576.323)	-0.605	0.545
MD_Kurtosis	3.572 (2.745, 4.823)	4.031 (2.682, 4.886)	-0.065	0.948
MD_Maximum	2991.131 ± 754.786	3186.573 ± 861.932	-0.845	0.402
MD_Mean	1400.067 ± 323.148	1437.302 ± 249.188	-0.420	0.676
MD_MeanAbsoluteDeviation	251.971 (195.345, 344.176)	306.66 (229.395, 343.589)	-0.717	0.473
MD_Median	1361.172 (1112.34, 1528)	1402.973 (1258.225, 1513.841)	-0.587	0.557
MD_Minimum	548 (408.363, 636.687)	576.049 (307.219, 621.78)	-0.121	0.904
MD_Range	2497.961 ± 847.821	2698.183 ± 966.055	-0.771	0.444
MD_RobustMeanAbsoluteDeviation	175.06 (132.047, 237.303)	180.997 (151.845, 229.518)	-0.512	0.609
MD_RootMeanSquared	1450.806 ± 350.553	1492.71 ± 272.33	-0.435	0.665
MD_Skewness	0.641 (0.311, 1.153)	0.724 (0.239, 1.154)	-0.233	0.816
MD_TotalEnergy	18952517534.088 (7735794378.461, 107057308469.268)	149328791522.544 (13914716667.495, 236881968852.389)	-1.946	0.052

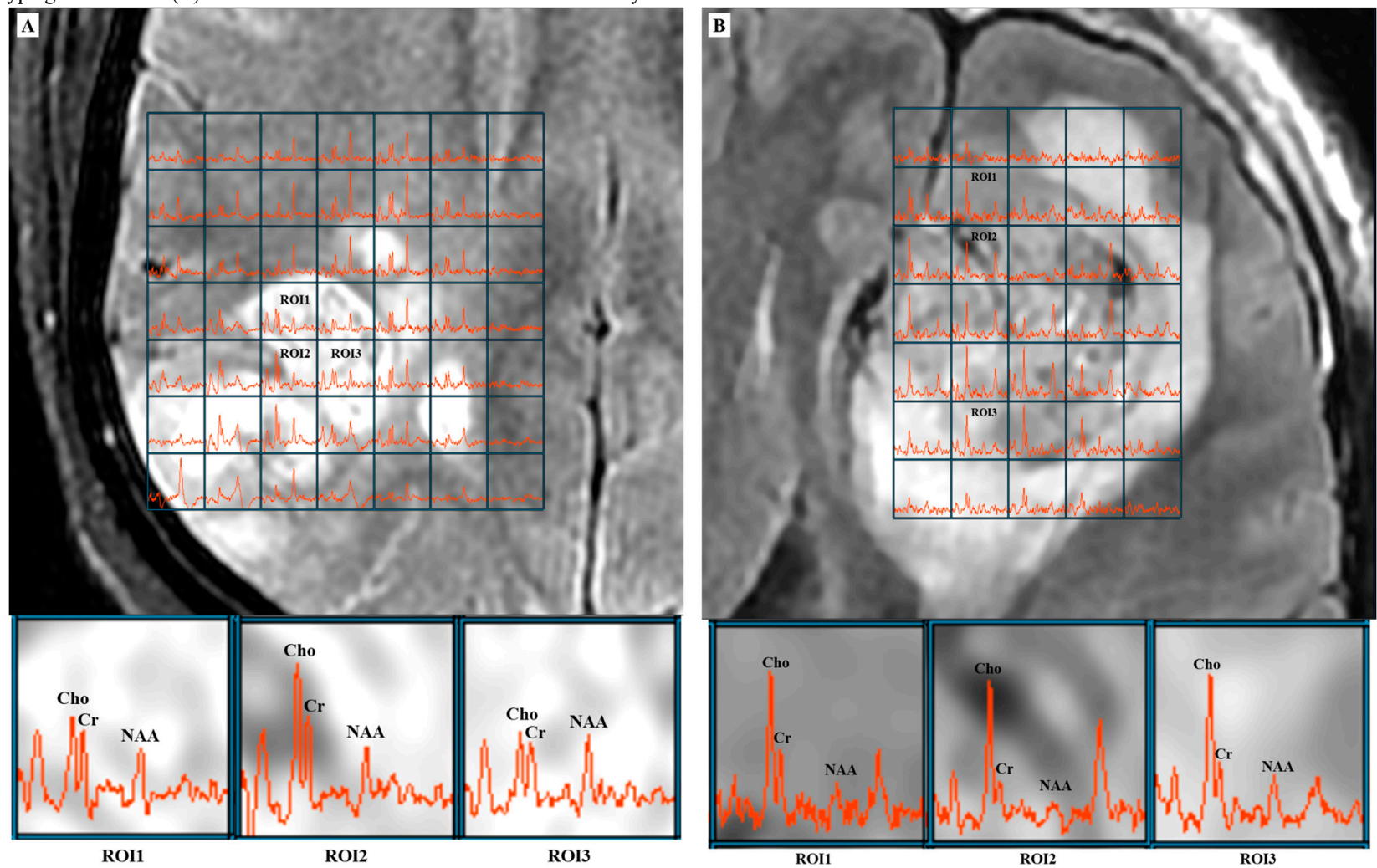
MD_Uniformity	0.027 (0.022, 0.036)	0.023 (0.019, 0.032)	-0.996	0.319
MD_Variance	99733.282 (75521.389, 204087.381)	138777.549 (81615.48, 233815.145)	-0.847	0.397
<b>DTI clinical parameters</b>				
FA2d_Maximum	0.288 (0.193, 0.329)	0.242 (0.205, 0.271)	-0.773	0.440
FA2d_Maximum_ratio	0.514 ± 0.202	0.474 ± 0.194	0.686	0.496
FA2d_Mean	0.177 ± 0.065	0.166 ± 0.048	0.635	0.528
FA2d_Mean_ratio	0.44 ± 0.159	0.411 ± 0.144	0.642	0.524
FA2d_Median	0.174 ± 0.068	0.16 ± 0.05	0.718	0.476
FA2d_Median_ratio	0.432 ± 0.169	0.404 ± 0.145	0.606	0.547
FA2d_Minimum	0.11 ± 0.053	0.097 ± 0.038	0.946	0.349
FA2d_Minimum_ratio	0.427 ± 0.22	0.351 ± 0.202	1.213	0.231
MD2d_Maximum	1375.498 ± 314.319	1446.83 ± 312.213	-0.776	0.441
MD2d_Maximum_ratio	1.514 ± 0.401	1.664 ± 0.339	-1.336	0.187
MD2d_Mean	1131.217 ± 234.915	1143.407 ± 197.863	-0.186	0.853
MD2d_Mean_ratio	1.4 ± 0.33	1.451 ± 0.275	-0.555	0.581
MD2d_Median	1123.928 ± 245.298	1141.254 ± 209.11	-0.252	0.802
MD2d_Median_ratio	1.392 ± 0.344	1.45 ± 0.293	-0.597	0.553
MD2d_Minimum	924.713 ± 215.834	922.592 ± 204.69	0.034	0.973
MD2d_Minimum_ratio	1.289 ± 0.311	1.299 ± 0.357	-0.100	0.921

Note: MGMT, O6-methylguanine-DNA methyltransferase; MRS, magnetic resonance spectroscopy; Cho, Choline; NAA, N-acetyl-aspartate; Cr, Creatine; DTI, diffusion tensor imaging; FA, fractional anisotropy; MD, mean diffusivity.



Supplementary Figure S1. The ROI selection in multi-voxel 2D MRSI spectra for cases in the IDH-wildtype group and IDH-mutant group. (A) ROI selection in a case with

IDH-wildtype glioblastoma. (B) ROI selection in a case with IDH-mutant astrocytoma.



Supplementary Figure S2. The ROI selection in multi-voxel 2D MRSI spectra for cases in the MGMT-methylated group and MGMT-unmethylated group. **(A)** ROI selection in a glioblastoma case with methylated-MGMT promoter. **(B)** ROI selection in a glioblastoma case with unmethylated-MGMT promoter.