Multimodality MRI radiomics based on machine learning for identifying true tumor recurrence and treatment-related effects in postoperative glioma patients

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Table S1 Scanning protocols:

Scanner	Sequence	TR(ms)	TE(ms)	FOV(mm*mm)	Thickness(mm)	Spacing(mm)	NEX
GE	T1WI	1756.5	27.1	240*240	5.0	1.5	1
Discovery	CE-T1WI	1753.2	27.0	240*240	5.0	1.5	1
MR750	T2WI	7596.0	83.3	204*240	5.0	1.5	1
3.0T	FLAIR	9000.0	120.1	240*240	5.0	1.5	1
	T1WI	1711.8	8.5	240*240	5.0	1.5	1
GE HDxt	CE-T1WI	1711.8	6.6	240*240	5.0	1.5	1
3.0T	T2WI	7000.0	128.3	204*240	5.0	1.5	1
	FLAIR	9002.0	172.2	240*240	5.0	1.5	1

Table S2 Key radiomics features for each sequence.

Features	Coefficients
CE_T1WI_log-sigma-5-0-mm-3D_glrlm_LongRunLowGrayLevelEmphasis_PoE	0.010297
CE_T1WI_log-sigma-2-0-mm-3D_glszm_SmallAreaHighGrayLevelEmphasis_PoE	0.016721
CE_T1WI_wavelet-HLL_glcm_ClusterShade_PoE	0.028083
CE_T1WI_wavelet-LLL_glcm_MaximumProbability_PoE	-0.0322
CE_T1WI_original_glrlm_ShortRunEmphasis_PoE	-0.03481
CE_T1WI_log-sigma-4-0-mm-3D_ngtdm_Busyness_PoE	-0.03527
CE_T1WI_wavelet-LLL_glszm_ZoneVariance_PoE	0.038569
CE_T1WI_log-sigma-5-0-mm-3D_glszm_ZoneEntropy_PoE	0.04108
CE_T1WI_wavelet-LHL_glcm_Imc2_PoE	-0.04585
CE_T1WI_log-sigma-3-0-mm-3D_glrlm_LowGrayLevelRunEmphasis_ED	-0.00847
CE_T1WI_wavelet-LLH_firstorder_Skewness_ED	-0.00694
CE_T1WI_wavelet-LLL_glszm_GrayLevelNonUniformity_ED	0.002847
CE_T1WI_wavelet-LLL_glszm_ZoneEntropy_ED	0.009758
CE_T1WI_wavelet-LLH_firstorder_Range_ED	0.015737
CE_T1WI_wavelet-LHL_firstorder_Mean_ED	0.029765
CE_T1WI_log-sigma-1-0-mm-3D_firstorder_Maximum_ED	0.072432
CE_T1WI_log-sigma-2-0-mm-3D_glszm_LowGrayLevelZoneEmphasis_ED	0.117593
T1WI_log-sigma-3-0-mm-3D_ngtdm_Contrast_PoE	0.175461
T1WI_log-sigma-5-0-mm-3D_glszm_LowGrayLevelZoneEmphasis_PoE	-0.08064
T1WI_wavelet-LHL_firstorder_Skewness_PoE	0.077078
T1WI_wavelet-LHL_firstorder_TotalEnergy_PoE	0.047036
T1WI_wavelet-LLH_glrlm_RunVariance_PoE	-0.04118
T1WI_wavelet-HLH_firstorder_Range_PoE	0.040582
T1WI_wavelet-LLH_glszm_GrayLevelNonUniformity_PoE	0.039957
T1WI_original_glrlm_LongRunLowGrayLevelEmphasis_PoE	0.036254
T1WI_log-sigma-1-0-mm-3D_glrlm_ShortRunHighGrayLevelEmphasis_PoE	0.029612
T1WI_wavelet-HHL_glcm_JointEntropy_PoE	-0.02844
T1WI_wavelet-LHL_firstorder_TotalEnergy_ED	0.053071
T1WI_log-sigma-5-0-mm-3D_firstorder_Maximum_ED	0.053042
T1WI_wavelet-LLL_glcm_ClusterShade_ED	0.042879

T1WI_log-sigma-4-0-mm-3D_glszm_ZoneEntropy_ED	0.039844
T1WI_log-sigma-4-0-mm-3D_glszm_LowGrayLevelZoneEmphasis_ED	0.033643
T1WI_log-sigma-2-0-mm-3D_ngtdm_Busyness_ED	0.022687
T1WI_wavelet-HLL_firstorder_Kurtosis_ED	0.022528
T1WI_wavelet-HHL_glcm_MaximumProbability_ED	0.020227
FLAIR_wavelet-LLH_glszm_GrayLevelNonUniformity_PoE	0.125711
FLAIR_wavelet-LLL_glrlm_RunVariance_PoE	-0.10197
FLAIR_original_ngtdm_Contrast_PoE	-0.10037
FLAIR_wavelet-LLL_firstorder_Skewness_PoE	-0.06961
FLAIR_wavelet-LLH_firstorder_90Percentile_PoE	-0.06586
FLAIR_wavelet-HLH_firstorder_Range_PoE	0.061094
FLAIR_wavelet-LLL_glszm_ZonePercentage_PoE	-0.04441
FLAIR_wavelet-HLL_glcm_SumEntropy_PoE	0.040916
FLAIR_wavelet-LLH_firstorder_Kurtosis_PoE	0.034081
FLAIR_wavelet-LHL_glcm_MCC_PoE	-0.03094
FLAIR_log-sigma-4-0-mm-3D_glcm_ClusterShade_ED	0.089821
FLAIR_wavelet-LLL_firstorder_TotalEnergy_ED	0.073967
FLAIR_wavelet-LLH_glrlm_GrayLevelVariance_ED	-0.06094
FLAIR_wavelet-LLH_firstorder_Median_ED	0.047708
FLAIR_wavelet-HLH_glcm_MaximumProbability_ED	0.025577
FLAIR_wavelet-HLL_glrlm_ShortRunEmphasis_ED	-0.02432
FLAIR_wavelet-HHL_glcm_MCC_ED	0.023742
FLAIR_wavelet-LLL_firstorder_RobustMeanAbsoluteDeviation_ED	-0.02322
FLAIR_wavelet-LHL_glszm_SizeZoneNonUniformity_ED	0.021945
FLAIR_original_ngtdm_Complexity_ED	0.012621
T2WI_wavelet-LLL_glcm_ClusterShade_PoE	0.148926
T2WI_wavelet-LLH_firstorder_Range_PoE	-0.09615
T2WI_wavelet-LLL_glrlm_GrayLevelNonUniformity_PoE	0.072442
T2WI_log-sigma-1-0-mm-3D_firstorder_Kurtosis_PoE	0.056458
T2WI_wavelet-HHL_firstorder_Kurtosis_PoE	0.043675
T2WI_wavelet-LLH_firstorder_Variance_PoE	-0.02831
T2WI_wavelet-HLL_gldm_GrayLevelVariance_PoE	0.0223
T2WI_log-sigma-5-0-mm-3D_firstorder_RootMeanSquared_PoE	-0.01666
T2WI_log-sigma-1-0-mm-3D_gldm_LowGrayLevelEmphasis_PoE	-0.01256
T2WI_wavelet-LLH_firstorder_Range_ED	-0.07108
T2WI_wavelet-HLL_firstorder_Mean_ED	-0.05148
T2WI_wavelet-LHL_glcm_JointEntropy_ED	-0.04224
T2WI_wavelet-LHL_glrlm_ShortRunLowGrayLevelEmphasis_ED	-0.04102
T2WI_original_shape_Maximum3DDiameter_ED	0.04057
T2WI_wavelet-LLH_glcm_JointEntropy_ED	-0.03065
T2WI_log-sigma-5-0-mm-3D_glszm_ZoneEntropy_ED	0.020248
T2WI_wavelet-HHH_ngtdm_Contrast_ED	-0.01683

Note: The best subset of features filtered from each single sequence, the coefficient is calculated by the Least absolute shrinkage and selection operator . PoE represents

features from the postoperative residual tumor cavity and areas of abnormal enhancement; ED represents features from the edematous areas surrounding the tumor

Table S3 Diagnostic performance of all models in the training set.

Classifier	Sequence	Region	AUC	95% CI	Acc (%)	Sen (%)	Spe (%)
SVM	T1WI	PoE	0.944	0.898 - 0.990	84.6	91.5	88.6
		ED	0.926	0.872 - 0.979	86.8	91.5	81.8
		Whole	0.977	0.955 - 0.999	90.1	85.1	100.0
	CE-T1WI	PoE	0.939	0.882 - 0.997	90.1	93.6	88.6
		ED	0.922	0.866 - 0.978	85.7	87.2	86.4
		Whole	0.942	0.879 - 1.000	91.2	98.2	86.1
	T2-FLAIR	PoE	0.902	0.819 - 0.985	87.9	96.4	83.3
		ED	0.911	0.855 - 0.966	80.2	91.5	72.7
		Whole	0.976	0.953 - 0.999	87.9	83.0	100.0
	T2WI	PoE	0.923	0.853 - 0.994	91.2	94.5	88.9
		ED	0.913	0.850 - 0.975	84.6	78.2	88.9
		Whole	0.962	0.923 - 1.000	90.1	89.4	95.5
	Multimodality	PoE	0.965	0.927 - 1.000	91.2	89.4	93.2
		ED	0.985	0.969 - 1.000	93.4	91.5	95.5
		Whole	0.994	0.984 - 1.000	96.7	93.6	100.0
KNN	T1WI	PoE	0.900	0.844 - 0.957	79.1	72.3	86.4
		ED	0.870	0.798 - 0.943	81.3	78.7	84.1
		Whole	0.920	0.865 - 0.975	83.5	93.6	79.5
	CE-T1WI	PoE	0.949	0.907 - 0.991	90.1	98.2	77.8
		ED	0.905	0.847 - 0.963	83.5	83.0	84.1
		Whole	0.950	0.911 - 0.989	89.0	95.7	81.8
	T2-FLAIR	PoE	0.869	0.800 - 0.939	79.1	80.9	77.3
		ED	0.864	0.795 - 0.934	76.9	76.6	77.3
		Whole	0.905	0.846 - 0.963	82.4	72.7	97.2
	T2WI	PoE	0.940	0.901 - 0.982	85.7	89.4	81.8
		ED	0.848	0.773 - 0.925	79.1	81.8	75.0
		Whole	0.942	0.901 - 0.983	85.7	93.6	77.3
	Multimodality	PoE	0.922	0.871 - 0.973	85.7	87.2	84.1
		ED	0.953	0.916 - 0.990	87.9	87.2	88.6
		Whole	0.966	0.937 - 0.995	89.0	87.2	90.9

Note: SVM: Support Vector Machine; KNN: K-Nearest Neighbor; PoE: Features from the postoperative enhancement regions; ED: Features from the edematous regions; All: Includes features of postoperative regions and edematous regions; Multiple: Includes all sequences; Acc: accuracy, Sen: sensitivity, Spe: specificity.