

Appendix 1

MRI data in our hospital were acquired using two 3.0T MRI scanners, including Achieva (Philips Medical Systems, Best, Netherlands) and Ingenia (Philips Medical Systems).

Structural MRI: T1WI and T1CE [repetition time (TR)/ echo time (TE) =7.9/3.1 ms; inversion time (TI) =810 ms; flip angle (FA) =10°; matrix =256 × 256; field of view (FOV) =256 × 232 mm²; slice thickness =1 mm]. T2WI (TR/TE =2,200/606.36 ms; TI =1,519 ms; FA: from 19° to 150°; matrix=256 × 256; FOV =256 × 232 mm²; slice thickness =1 mm). FLAIR (TR/TE =4,800/428.04 ms; TI =1,519 ms; FA: from 21° to 150°; matrix =240 × 240; FOV =256 × 232 mm²; slice thickness =1 mm).

DWI (TR/TE =3,598/108 ms; FA =90°; matrix =144 × 144; FOV = 230 × 230 mm²; slice thickness =5 mm). ADC map was calculated spontaneously from 2 b-value maps (0 and 1,000). SWI (TR/TE =24/34 ms; FA =17°; matrix =256 × 256; FOV = 240 × 190 mm²; slice thickness =2 mm).

The time of all MRI sequences for one patient was 16 min and 42 s.

Table S1 Features selected in the structural MRI model

Feature name
T1c_TC.LoG.grlm.RunEntropy
T1c_TC.gradient.firstorder.Skewness
T1c_TC.gradient.grlm.RunEntropy
T1c_TC.gradient.glszm.LowGrayLevelZoneEmphasis
T1c_TC.LoG.firstorder.Entropy
T1c_TC.wavelet.LLH.glszm.GrayLevelNonUniformityNormalized
T1c_TC.gradient.firstorder.Entropy
T1c_TC.gradient.firstorder.Kurtosis
T1c_TC.wavelet.LLH.gldm.DependenceEntropy
T1c_TC.gradient.firstorder.90Percentile
T1c_TC.LoG.glszm.GrayLevelNonUniformityNormalized
T1c_TC.wavelet.LLH.glszm.GrayLevelNonUniformityNormalized
T1c_TC.wavelet.LLH.grlm.RunEntropy
T1c_TC.square.firstorder.90Percentile
T1c_TC.wavelet.LHL.gldm.DependenceEntropy
T1c_TC.wavelet.LLH.gldm.DependenceEntropy
T1c_TC.LoG.firstorder.90Percentile
T1c_wholeTumor.gradient.firstorder.Kurtosis
T1c_wholeTumor.gradient.glszm.GrayLevelNonUniformityNormalized
T1c_TC.wavelet.LHL.glszm.GrayLevelNonUniformityNormalized
T1c_TC.wavelet.LLH.grlm.RunEntropy
T1c_wholeTumor.wavelet.LLH.glszm.GrayLevelNonUniformityNormalized
T1c_TC.wavelet.LHL.grlm.RunEntropy
T1c_TC.wavelet.LLH.firstorder.Kurtosis
T1c_TC.LoG.firstorder.Kurtosis
T1c_TC.squareroot.gldm.DifferenceEntropy
T1c_wholeTumor.LoG.grlm.RunEntropy
T1c_TC.wavelet.LLH.glszm.ZoneEntropy
T1c_TC.squareroot.gldm.JointEntropy
T1c_TC.gradient.gldm.DependenceEntropy
T1c_wholeTumor.LoG.glszm.GrayLevelNonUniformityNormalized
T1c_wholeTumor.wavelet.LLH.glszm.ZoneEntropy
T1c_TC.wavelet.LLH.firstorder.10Percentile
T1c_TC.gradient.ngtdm.Complexity
T1c_wholeTumor.original.firstorder.Mean
T1c_TC.square.gldm.DifferenceEntropy
T1c_TC.square.grlm.GrayLevelNonUniformityNormalized
T1c_TC.squareroot.firstorder.Entropy
T1c_TC.wavelet.LLH.glszm.ZoneEntropy
T1c_TC.lbp.3D.k.firstorder.10Percentile

MRI, magnetic resonance imaging.

Table S2 Features selected in the ADC model

ADC_TC.original.firstorder.10Percentile
ADC_TC.square.firstorder.10Percentile
ADC_wholeTumor.original.firstorder.10Percentile
ADC_TC.original.firstorder.Mean
ADC_TC.squareroot.firstorder.10Percentile
ADC_wholeTumor.original.shape.Sphericity
ADC_wholeTumor.original.firstorder.Mean
ADC_TC.square.firstorder.Median
ADC_TC.square.gldm.LargeDependenceHighGrayLevelEmphasis
ADC_TC.square.firstorder.Minimum
ADC_TC.squareroot.firstorder.Mean
ADC_TC.log-sigma-3-0-mm-3D.firstorder.90Percentile
ADC_TC.lbp.3D.m1.glszm.HighGrayLevelZoneEmphasis
ADC_TC.lbp.3D.m1.glszm.SmallAreaHighGrayLevelEmphasis
ADC_TC.exponential.firstorder.Minimum
ADC_wholeTumor.square.firstorder.Median
ADC_TC.wavelet.LLH.firstorder.Median
ADC_TC.exponential.grlm.LongRunHighGrayLevelEmphasis
ADC_TC.square.firstorder.Mean
ADC_TC.log-sigma-3-0-mm-3D.firstorder.Mean
ADC_wholeTumor.square.firstorder.10Percentile
ADC_TC.exponential.gldm.LargeDependenceHighGrayLevelEmphasis
ADC_TC.lbp.3D.m1.grlm.HighGrayLevelRunEmphasis
ADC_TC.square.grlm.HighGrayLevelRunEmphasis
ADC_TC.LoG.firstorder.Median
ADC_TC.original.shape.Sphericity
ADC_wholeTumor.square.gldm.LargeDependenceHighGrayLevelEmphasis
ADC_TC.lbp.3D.m1.firstorder.90Percentile
ADC_wholeTumor.squareroot.firstorder.Mean
ADC_wholeTumor.squareroot.firstorder.10Percentile
ADC_TC.squareroot.firstorder.Skewness
ADC_wholeTumor.square.grlm.LongRunHighGrayLevelEmphasis
ADC_TC.lbp.3D.k.firstorder.RootMeanSquared
ADC_TC.wavelet.LLH.firstorder.90Percentile
ADC_TC.wavelet.LLH.firstorder.Kurtosis
ADC_wholeTumor.square.firstorder.Mean
ADC_TC.square.firstorder.Skewness
ADC_TC.wavelet.LHL.firstorder.90Percentile
ADC_TC.LoG.firstorder.90Percentile
ADC_wholeTumor.log-sigma-3-0-mm-3D.firstorder.90Percentile

ADC, apparent diffusion coefficient.

Table S3 Features selected in the SWI model

SWI_TC_wavelet-LHL_glszm_ZoneEntropy
SWI_TC_wavelet-HHL_glszm_ZoneEntropy
SWI_TC_wavelet-LHL_gldm_DependenceEntropy
SWI_TC_wavelet-HHL_glcm_MCC
SWI_TC_wavelet-HHL_gldm_DependenceEntropy
SWI_TC_wavelet-LHL_glcm_MCC
SWI_TC_Log_firstorder_Maximum
SWI_TC_wavelet-LHL_glszm_GrayLevelNonUniformityNormalized
SWI_TC_wavelet-HLL_glcm_MCC
SWI_TC_wavelet-HHL_firstorder_10Percentile
SWI_TC_square_glcm_lmc1
SWI_TC_Log_glcm_MCC
SWI_TC_gradient_glszm_ZoneEntropy
SWI_TC_wavelet-LHH_glszm_ZoneEntropy
SWI_TC_log-sigma-3-0-mm-3D_firstorder_Maximum
SWI_TC_wavelet-HLL_firstorder_10Percentile
SWI_TC_wavelet-HHL_glszm_GrayLevelNonUniformityNormalized
SWI_TC_wavelet-LHL_firstorder_Kurtosis
SWI_wholeTumor_Log_firstorder_Maximum
SWI_TC_wavelet-LLH_glcm_MCC
SWI_TC_wavelet-LLH_firstorder_Skewness
SWI_TC_wavelet-HLL_glszm_ZoneEntropy
SWI_wholeTumor_Log_glcm_ClusterShade
SWI_TC_exponential_glcm_JointEntropy
SWI_TC_wavelet-HLL_gldm_DependenceEntropy
SWI_TC_square_gldm_LargeDependenceHighGrayLevelEmphasis
SWI_TC_wavelet-LHL_glrIm_RunEntropy
SWI_TC_wavelet-LLH_glszm_ZoneEntropy
SWI_wholeTumor_gradient_ngtdm_Strength
SWI_TC_gradient_firstorder_90Percentile
SWI_TC_gradient_gldm_DependenceEntropy
SWI_TC_wavelet-LHH_glcm_MCC
SWI_wholeTumor_log-sigma-3-0-mm-3D_glszm_SizeZoneNonUniformityNormalized
SWI_TC_Log_firstorder_Range
SWI_TC_wavelet-HLH_glcm_MCC
SWI_TC_Log_glszm_ZoneEntropy
SWI_TC_wavelet-LHH_firstorder_10Percentile
SWI_wholeTumor_wavelet-LHL_glszm_ZoneEntropy
SWI_wholeTumor_log-sigma-3-0-mm-3D_glszm_SmallAreaHighGrayLevelEmphasis
SWI_TC_wavelet-HLL_firstorder_Maximum

SWI, susceptibility-weighted imaging.

Table S4 Features selected in model Structural MRI+ADC

T1c_TC_Log_glrIm_RunEntropy
T1c_TC_gradient_firstorder_Skewness
T1c_TC_gradient_glrIm_RunEntropy
T1c_TC_gradient_glszm_LowGrayLevelZoneEmphasis
T1c_TC_Log_firstorder_Entropy
T1c_TC_wavelet-LLH_glszm_GrayLevelNonUniformityNormalized
T1c_TC_gradient_firstorder_Entropy
T1c_TC_gradient_firstorder_Kurtosis
T1c_TC_wavelet-LLH_gldm_DependenceEntropy
T1c_TC_gradient_firstorder_90Percentile
T1c_TC_Log_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-HLL_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LLH_glrIm_RunEntropy
T1c_TC_square_firstorder_90Percentile
T1c_TC_wavelet-LHL_gldm_DependenceEntropy
T1c_TC_wavelet-HLL_gldm_DependenceEntropy
T1c_TC_Log_firstorder_90Percentile
T1c_wholeTumor_gradient_firstorder_Kurtosis
T1c_wholeTumor_gradient_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LHL_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-HLL_glrIm_RunEntropy
T1c_wholeTumor_wavelet-LLH_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LHL_glrIm_RunEntropy
T1c_TC_wavelet-HLL_firstorder_Kurtosis
T1c_TC_Log_firstorder_Kurtosis
ADC_TC_original_firstorder_10Percentile
ADC_TC_square_firstorder_10Percentile
ADC_wholeTumor_original_firstorder_10Percentile
ADC_TC_original_firstorder_Mean
ADC_TC_squareroot_firstorder_10Percentile
ADC_wholeTumor_original_shape_Sphericity
ADC_wholeTumor_original_firstorder_Mean
ADC_TC_square_firstorder_Median
ADC_TC_square_gldm_LargeDependenceHighGrayLevelEmphasis
ADC_TC_square_firstorder_Minimum
ADC_TC_squareroot_firstorder_Mean
ADC_TC_log-sigma-3-0-mm-3D_firstorder_90Percentile
ADC_TC_lbp-3D-m1_glszm_HighGrayLevelZoneEmphasis
ADC_TC_lbp-3D-m1_glszm_SmallAreaHighGrayLevelEmphasis
ADC_TC_exponential_firstorder_Minimum

MRI, magnetic resonance imaging; ADC, apparent diffusion coefficient.

Table S5 Features selected in model Structural MRI+SWI

T1c_TC_LoG_glrIm_RunEntropy
T1c_TC_gradient_firstorder_Skewness
T1c_TC_gradient_glrIm_RunEntropy
T1c_TC_gradient_glszm_LowGrayLevelZoneEmphasis
T1c_TC_LoG_firstorder_Entropy
T1c_TC_wavelet-LLH_glszm_GrayLevelNonUniformityNormalized
T1c_TC_gradient_firstorder_Entropy
T1c_TC_gradient_firstorder_Kurtosis
T1c_TC_wavelet-LLH_gldm_DependenceEntropy
T1c_TC_gradient_firstorder_90Percentile
T1c_TC_LoG_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-HLL_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LLH_glrIm_RunEntropy
T1c_TC_square_firstorder_90Percentile
T1c_TC_wavelet-LHL_gldm_DependenceEntropy
T1c_TC_wavelet-HLL_gldm_DependenceEntropy
T1c_TC_LoG_firstorder_90Percentile
T1c_wholeTumor_gradient_firstorder_Kurtosis
T1c_wholeTumor_gradient_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LHL_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-HLL_glrIm_RunEntropy
T1c_wholeTumor_wavelet-LLH_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LHL_glrIm_RunEntropy
T1c_TC_wavelet-HLL_firstorder_Kurtosis
T1c_TC_LoG_firstorder_Kurtosis
SWI_TC_wavelet-LHL_glszm_ZoneEntropy
SWI_TC_wavelet-HHL_glszm_ZoneEntropy
SWI_TC_wavelet-LHL_gldm_DependenceEntropy
SWI_TC_wavelet-HHL_glcm_MCC
SWI_TC_wavelet-HHL_gldm_DependenceEntropy
SWI_TC_wavelet-LHL_glcm_MCC
SWI_TC_LoG_firstorder_Maximum
SWI_TC_wavelet-LHL_glszm_GrayLevelNonUniformityNormalized
SWI_TC_wavelet-HLL_glcm_MCC
SWI_TC_wavelet-HHL_firstorder_10Percentile
SWI_TC_square_glcm_lmc1
SWI_TC_LoG_glcm_MCC
SWI_TC_gradient_glszm_ZoneEntropy
SWI_TC_wavelet-LHH_glszm_ZoneEntropy
SWI_TC_log-sigma-3-0-mm-3D_firstorder_Maximum

MRI, magnetic resonance imaging; SWI, susceptibility-weighted imaging.

Table S6 Features selected in model Structural MRI + ADC + SWI

T1c_TC_LoG_glrIm_RunEntropy
T1c_TC_gradient_firstorder_Skewness
T1c_TC_gradient_glrIm_RunEntropy
T1c_TC_gradient_glszm_LowGrayLevelZoneEmphasis
T1c_TC_LoG_firstorder_Entropy
T1c_TC_wavelet-LLH_glszm_GrayLevelNonUniformityNormalized
T1c_TC_gradient_firstorder_Entropy
T1c_TC_gradient_firstorder_Kurtosis
T1c_TC_wavelet-LLH_gldm_DependenceEntropy
T1c_TC_gradient_firstorder_90Percentile
T1c_TC_LoG_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-HLL_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LLH_glrIm_RunEntropy
T1c_TC_square_firstorder_90Percentile
T1c_TC_wavelet-LHL_gldm_DependenceEntropy
T1c_TC_wavelet-HLL_gldm_DependenceEntropy
T1c_TC_LoG_firstorder_90Percentile
T1c_wholeTumor_gradient_firstorder_Kurtosis
T1c_wholeTumor_gradient_glszm_GrayLevelNonUniformityNormalized
T1c_TC_wavelet-LHL_glszm_GrayLevelNonUniformityNormalized
ADC_TC_original_firstorder_10Percentile
ADC_TC_square_firstorder_10Percentile
ADC_wholeTumor_original_firstorder_10Percentile
ADC_TC_original_firstorder_Mean
ADC_TC_squareroot_firstorder_10Percentile
ADC_wholeTumor_original_shape_Sphericity
ADC_wholeTumor_original_firstorder_Mean
ADC_TC_square_firstorder_Median
ADC_TC_square_gldm_LargeDependenceHighGrayLevelEmphasis
ADC_TC_square_firstorder_Minimum
SWI_TC_wavelet-LHL_glszm_ZoneEntropy
SWI_TC_wavelet-HHL_glszm_ZoneEntropy
SWI_TC_wavelet-LHL_gldm_DependenceEntropy
SWI_TC_wavelet-HHL_glcm_MCC
SWI_TC_wavelet-HHL_gldm_DependenceEntropy
SWI_TC_wavelet-LHL_glcm_MCC
SWI_TC_LoG_firstorder_Maximum
SWI_TC_wavelet-LHL_glszm_GrayLevelNonUniformityNormalized
SWI_TC_wavelet-HLL_glcm_MCC
SWI_TC_wavelet-HHL_firstorder_10Percentile

MRI, magnetic resonance imaging; ADC, apparent diffusion coefficient; SWI, susceptibility-weighted imaging.