The detail information for radiographic-related models in predicting PD-1 expression and overall survival.

1. Model explanation or supplementary (PD-1/PD-L1 expression models)

In Table 3 (the model performance for predicting PD-1/PD-L1 expression), the models involving clinical or radiographic features were constructed as follows (The PD-L1 predicting model only contained radiomics model as there is no clinical or radiographic feature retained after univariate logistic regression):

(1) **Combined model:** univariate logistic regression was conducted to the mixture of the clinical features (19 features as shown in Table 1) and radiographic manifestations (12 features in Table 2). The features with P<0.05 were further mixed with the Radscore (from arterial phase with better predictive performance) to be screened by backward stepwise multivariate logistic regression (minimum AIC criteria). And the final "Combined model" was constructed by logistic regression method using the formula below:

Score$^{\text{combined model}}$ =

0.67+1.06×Radscore + 0.86×pathology -1.14×Imaging.Classification -1.55×Enhancement + 1.38×Intratumor.Vascularity

in which "pathology" is clinical feature and "Imaging.Classification", "Enhancement", "Intratumor.Vascularity" are radiographic features.

And the Odds ratio of each selected features were summarized in Table S6 below.

Table S6: he Odds ratio of each selected feature in the Combined model after multivariate logistic regression.

	Regression Coefficient	P-value	Odds ratio(95%CI)
Radscore	1.06	0.0004	2.892(1.604-5.215)
pathology	0.86	0.1441	2.364(0.745-7.5)
Imaging.Classification	-1.14	0.1565	0.319(0.066-1.55)
Enhancement	-1.55	0.0350	0.212(0.05-0.897)
Intratumor.Vascularity	1.38	0.1199	3.969(0.699-22.555)

(2) **Radscore-radiologic model (corrected in Table 3)**: univariate logistic regression was conducted to the radiographic manifestations (12 features in Table 2). The features with P<0.05 were further mixed with the Radscore (from arterial phase with better predictive performance) to be screened by backward stepwise multivariate logistic regression (minimum AIC criteria). And the final "Radscore-radiologic" was constructed by logistic regression method using the formula below:

Score $^{\text{Radscore-radiologic}}$ =

1.16+0.93×Radscore -1.09×Enhancement + 1.43×Intratumor.Vascularity

in which, "Enhancement", "Intratumor.Vascularity" are radiographic features.

And the Odds ratio of each selected features were summarized in Table S7 below.

Table S7: The Odds ratio of each selected feature in the Radscore-radiologic model after multivariate logistic regression.

	Regression Coefficient	P-value	Odds ratio(95%CI)
Radscore	0.93	0.0004	2.546(1.514-4.281)
Enhancement	-1.09	0.0807	0.337(0.099-1.142)
Intratumor.Vascularity	1.43	0.0711	4.189(0.884-19.849)

(3) **Clinical-radiologic model (corrected in Table 3):** Actually, when we mixed the clinical and radiographic features and conducted univariate and multivariate logistic regression analysis, only two radiographic features (enhancement and Intratumor.Vascularity) left. So, we used directly the clinical and radiographic features selected in the "Combined model" to construct the "Clinical-radiologic model". The regression formula was listed below:

Score $^{\text{Clinical-radiologic}}$ =

-0.34 + 0.43×pathology + 0.25×Imaging.Classification -1.11×Enhancement + 1.71×Intratumor.Vascularity

in which "pathology" is clinical feature and "Imaging.Classification", "Enhancement", "Intratumor.Vascularity" are radiographic features.

And the Odds ratio of each selected features were summarized in Table S8 below.

Table S8: The Odds ratio of each selected feature in the Clinical-radiologic model.

	Regression Coefficient	P-value	Odds ratio(95%CI)
pathology	0.43	0.3410	1.544(0.631-3.776)
Imaging.Classification	0.25	0.6711	1.283(0.406-4.053)
Intratumor.Vascularity	1.71	0.0252	5.524(1.237-24.665)
Enhancement	-1.11	0.0590	0.331(0.105-1.043)

(4) **Radiologic model (supplemented in Table 3)**: univariate and backward stepwise multivariate logistic regression were conducted to the radiographic manifestations (12 features in Table 2). And the final "Radiologic model" was constructed by logistic regression method using the formula below:

$$\mathbf{Score}^{\text{Radiologic model}} =$$

0.983 -1.26×Enhancement + 1.96×Intratumor.Vascularity

And the Odds ratio of each selected features were summarized in Table S9 below.

Table S9: The Odds ratio of each selected feature in the Radiologic model after multivariate logistic regression.

	Regression Coefficient	P-value	Odds ratio(95%CI)
Enhancement	-1.26	0.0178	0.283(0.1-0.804)
Intratumor.Vascularity	1.96	0.0074	7.101(1.69-29.838)

(5) **Radscore-clinical model**: By univariate logistic regression, only "pathology" was retained and directly combined with Radscore (AP images) to construct Radscore-clinical model. The regression formula was as follows:

$$\mathbf{Score}^{\text{Radscore-radiologic}} =$$

-2.31+0.98×Radscore +1.00×Pathology

And the Odds ratio of each selected features were summarized in Table S10 below.

Table S10: The Odds ratio of each selected feature in the Radscore-clinical model after multivariate logistic regression.

	Regression Coefficient	P-value	Odds ratio(95%CI)
Pathology	1.00	0.0594	2.73(0.961-7.755)
Radscore	0.98	0.0002	2.672(1.604-4.45)

(6) The comparison between radiographic and radiomics-based models

As the radiographic features only retained in the PD-1 predicting models, the radiographic and radiomics models for PD-1 prediction were mainly compared here. Table S11 summarized P-value of the Delong's test between different models and Figure S9 illustrated the calibration curves of each compared models. As shown from the Table S11, there is no significant difference between Radiologic and Clinical-radiologic model. While, significant differences existed between Radiologic and Radiomics model ($P = 0.009$), Radiologic and Radiomics model combined independently with clinical or radiographic features or both of them ($P < 0.0001$).

Table S11: The Delong's test between radiographic and radiomics-based models.

Model comparison	**P-value of Delong's test**
Radiologic Model vs. Clinical-radiologic Model	0.244
Radiologic Model vs. Radscore (AP) Model	0.009
Radiologic Model vs. Radscore-radiologic Model	<0.0001
Radiologic Model vs. Combined Model	<0.0001

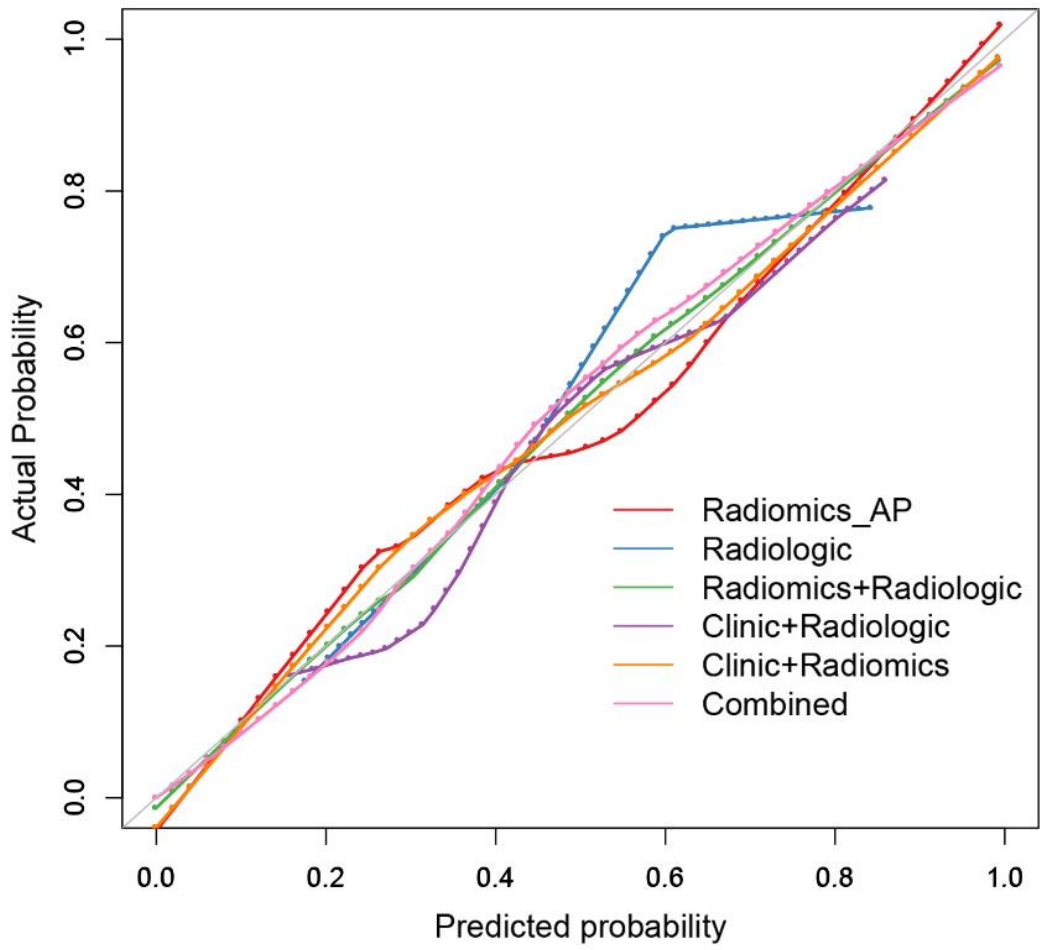

Figure S9: The calibration curves of radiographic and radiomics-based models in predicting PD-1 expression.

2. Radiographic features for predicting overall survival

In the manuscript, the imaging-based OS predicting model used features selected simultaneously from radiomics(AP), clinical factors and radiographic features. Here, we supplement the OS predicting model constructed from radiographic features alone or its combination with clinical factors. In brief, by combining clinical factors with radiographic features could enhance the OS predicting performance from C-index 0.653 to 0.675. However, the imaging-based OS model involving radiomics features performed better with C-index of 0.721.

(1) Radiologic OS model

We used the univariate and multivariate Cox regression to sequentially select the independent predictors for OS among 12 radiographic features. The Radiologic OS model (C-index, 0.653; 95% CI: 0.594-0.712) involved two independent predictors including “imaging classification” and “enhancement”, with a model cut value of -1.067. The formula for the Radiologic OS model is:

Risk3=0.845×imaging classification-1.068×Enhancement.

This model could divide ICC patients into high-risk (Risk3 value: -0.223) and low-risk groups (Median value of Risk3: -1.290, IQR: -2.135~-1.235) based on a cutoff value of -1.067. There were 58 patients in the high-risk group and 40 patients in low-risk group. The median survival time in these two groups was 19 months (IQR: 10–30.5 months) and 61 months (IQR: 21.25–65.75 months), respectively. The 1-, 3-, and 5-year survival rates of the high- and low-risk groups were 63.8%, 19.0%, and 11.8% and 85.0%, 67.5%, and 62.4%, respectively (p<0.001). The calibration curve and Kaplan-Meier curve for the Radiological model were illustrated in Figure S10 (A) and Figure S10 (C).

(2) Radiologic + Clinical OS model

We used the univariate and multivariate Cox regression to sequentially select the independent predictors for OS among 12 radiographic features and 19 clinical factors. The Radiologic-clinical OS model (C-index, 0.675; 95% CI: 0.610-0.740) involved two independent predictors including clinical factors “CEA” and radiographic feature “Imaging classification”, with a model cut value of 0.681. The formula for the Radiologic-clinical OS model is:

Risk4=0.681×CEA+1.299× Imaging.Classification.

This model could divide ICC patients into high-risk (Median value of Risk4: 1.299, IQR: 1.299~1.98) and low-risk groups (Risk4 value: 0.00) based on a cutoff value of 0.681. There were 83 patients in the high-risk group and 15 patients in low-risk group. The median survival time in these two groups was 22 months (IQR: 10–57 months) and 65 months (IQR: 61–71.5 months), respectively. The 1-, 3-, and 5-year survival rates of the high- and low-risk groups were 67.5%, 31.3%, and 23.8% and 100.0%, 81.0%, and 81.0%, respectively (p<0.001). The calibration curve and Kaplan-Meier curve for the Radiologic model were illustrated in Figure S10 (B) and Figure S10 (D).

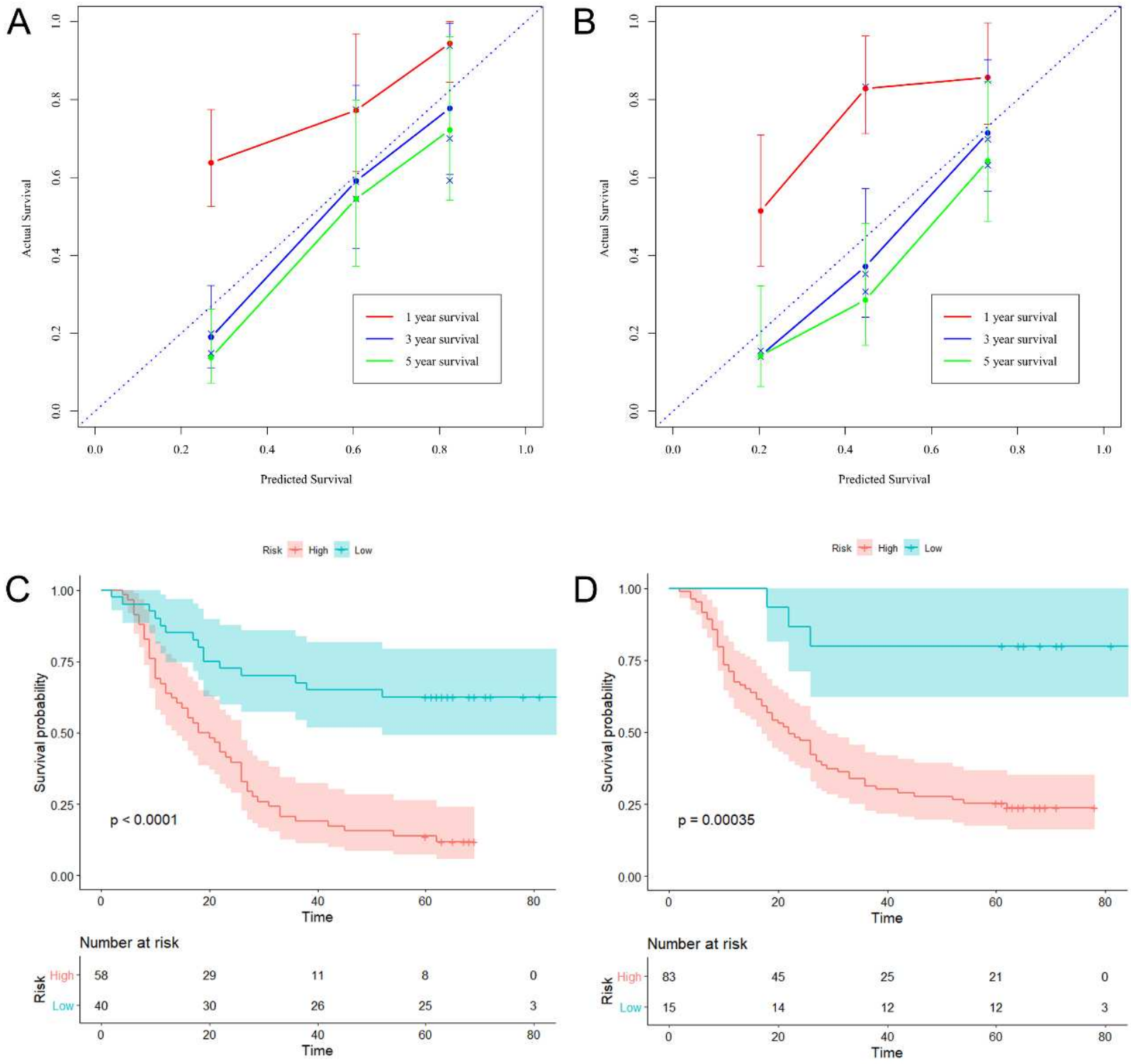

Figure S10: The calibration curves and Kaplan-Meier curves for Radiologic model and Radiologic-clinical model. (A) 1-, 3-, and 5-year calibration curves for Radiologic OS predicting model. (B) 1-, 3-, and 5-year calibration curves for Radiologic-clinical OS predicting model. (C) Kaplan-Meier curve for the Radiologic OS predicting model. (D) Kaplan-Meier curve for the Radiologic-clinical OS predicting model.