Effectiveness of CT-based Radiomics Features in Radiation Therapy for Patients with Non-Small Cell Lung Cancer

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Abstract: To analyze the effectiveness of CT-based radiomics features in the radiotherapy for patients with non-small cell lung cancer. 100 patients with non-small cell lung cancer who received corresponding treatment in the hospital from February 2022 to February 2023 were selected as subjects of the study, and they were randomly divided into the training group and the validation group. Patients in both groups underwent stereotactic radiotherapy. The study collects computed tomography (CT) images of the patients before treatment and extracts imaging features. The study uses the Least Absolute Shrinkage and Selection Operator (LASSO) to screen for the best omics features and analyzes the relationship between the efficacy of radiation therapy and radiomics features. The independent risk factors for the effectiveness of radiation therapy in patients include carcinoembryonic antigen (CEA), indoleamine 2, 3-dioxygenase (IDO), and radiomics signature. The efficacy of radiotherapy for patients with non-small cell lung cancer can be effectively evaluated by using CT-based radiomics features.

Keywords: Non-Small Cell Lung Cancer; Radiotherapy Effect; CT; Radiomics Features

1. Introduction

Non-small cell lung cancer is a malignant tumor of the respiratory tract in clinical practice. The main clinical symptoms of patients are difficulty breathing, doing a fever, hemoptysis, having a cough, etc. This disease has a high mortality rate. The priority treatment method for non-small cell lung cancer is surgical resection. However, when patients are unable to undergo surgical treatment, stereotactic radiation therapy can be used in clinical practice. After radiation therapy, the 3-year overall survival rate of patients can be further improved. But there is currently no sensitive method for detecting the effectiveness of radiation therapy and evaluating the prognosis [1]. In this study, the effectiveness of radiation therapy for patients was explored based on CT radiomics features, and the detailed content is as follows.

2. Information and Methods

2.1 General Information

100 patients with non-small cell lung cancer who received corresponding treatment in the hospital from February 2022 to February 2023 were selected as subjects of the study, and they were randomly divided into the training group and the validation group with a total of 50 patients in both groups. There were 32 male patients and 18 female patients in the training group, with an age range of 55-68 years and an average age of (62.18 ± 1.82) years. There are 31 male patients and 19 female patients in the validation group, with an age range of 56 to 72 years and an average age of (63.25 ± 1.05) years. After comparing the general information of patients in these two groups, the results suggest that the value of p is larger than 0.05.

2.2 Methods

This study first collected data on the patient's tumor location, tumor subtype, maximum tumor diameter, CEA, IDO activity, surgical pathological staging, and prescription dosage. The concentrations of kynurenine (Kyn) and tryptophan (Trp) were detected by using high-performance liquid chromatography. The value of IDO refers to Kyn/Trp, and the reference value that is equal to or larger than 0.034 is within the normal range. The CEA level is detected with the use of chemiluminescence immunoassay, and the reference value that is equal to or less than 5.0ng/ml is within the normal range.

All patients in this study used 64 slice spiral CT to perform effective chest plain and enhanced

scans. During the scanning, the tube voltage was set to 120kV, the tube current was set to 160mAs, the layer thickness was set to 1.25mm, the collimator was set to 0.625mm, and the FOV was set to 350mm×350mm, matrix set to 512×512. After completing the plain scanning, 0.01mmol/kg contrast agent gadolinium diamine was injected into the patient's elbow vein through a dual tube high-pressure syringe, with an injection rate at 2.5ml/s and a maximum dose at 100ml. After the patient completes the contrast agent injection for 20-30 seconds, arterial phase scanning is performed, and venous phase scanning is performed 60 seconds later. DICOM format is used to effectively export the scanned images.

This study correct multi phase CT images with the use of the non-rigid registration method of MIM Maestro software, and effectively delineate areas of interest in the contour of tumor lesions in CT images in arterial phase of patients by combining with threshold. Two doctors with more experience in CT diagnosis will review the film and extract the patient's CT image features by using 3D slicer 4.7.0 software.

2.3 Observation Indicators

The treatment effect is evaluated according to the RECIST 1.1 standard. Complete remission mainly refers to the disappearance of all target lesions, and partial remission mainly refers to a decrease of over 30% in lesion diameter. Disease progression mainly refers to an increase of over 20% in lesion diameter. Disease stability mainly refers to a decrease in lesion diameter of less than 30% or an increase of less than 20%. Complete and partial remission can be considered as effective treatment, while disease progression and disease stability are referred to as ineffective treatment [2].

2.4 Statistical Methods

Studio 3.0.1 statistical software was used for analysis in this study, and LASSO-Logistic regression analysis was used to construct an imaging omics model, which includes the imaging omics features of CT in the plain scan, arterial, and venous phases. SPSS 20.0 software was used for clinical data analysis, with count data expressed as percentages, chi square value as the study test value, measurement data expressed as mean ± standard deviation, and t-value as the study test value. If $p<0.05$, it can fully demonstrate the statistical significance of the research data.

3. Results

3.1 Analysis of Radiomics Signature

After LASSO-Logistic regression analysis, the optimal imaging features include: (1) During the flat scanning period, there are a total of 7 imaging features, including 3 wavelet transform features, 2 texture features, and 2 neighborhood grayscale difference matrix features. (2) During the arterial phase, there are a total of 15 imaging features, including 9 wavelet transform features, 3 grayscale band matrix features, and 3 first-order features. (3) During the venous phase, there are a total of 21 imaging features, including 12 wavelet transform features, 3 shape features, 4 neighborhood grayscale difference matrix features, and 2 first-order features. The radiomics signature is a linear combination of weighted coefficient product and optimal omics features. The radiomics signature of patients in the training group is -0.857 ± 0.272, while that in the validation group patients is -0.786 ± 0.245.

3.2 Logistic Regression Analysis of Factors Influencing Radiation Efficacy

The independent risk factors for the effectiveness of radiation therapy include radiomics signature, CEA, and IDO, the value of p is less than 0.05 which is shown in Table 1 below.

Table 1. Logistic Regression Analysis of Factors Influencing Radiation Efficacy

Items	β	OR	95%CI	p
interception	-1.738	-	-	0.006
radiomics signature	0.913	2.486	1.323-4.655	< 0.001
IDO	0.877	2.056	1.036-3.278	0.019
CEA	0.655	1.863	1.025-2.048	0.022

4. Discussion

Non-small cell lung cancer is a kind of lung cancer that is one of the malignant tumors with the fastest growth in incidence rate and mortality and the greatest threat to human health and life.

It is a disease that seriously affects organ function [3]. When patients with non-small cell lung cancer do not tolerate surgical treatment, they can choose stereotactic radiotherapy. Effective evaluation of the effectiveness of radiotherapy can effectively prevent complications after treatment and provide sufficient assurance for the quality of life of patients after radiotherapy.

CT examination is a commonly used imaging examination method in clinical practice. It has various advantages such as simple and convenient operation, low radiation, and fast scanning speed. However, CT cannot present heterogeneous information of tumors, making it difficult to effectively quantitatively analyze diseases [5]. CT-based radiomics analysis mainly refers to the effective transformation of CT images into high-dimensional quantitative feature data, which can effectively compensate for the disadvantages of CT examination. Scientific and accurate quantitative description of tumor heterogeneity in clinical practice can accurately predict tumor clinical staging and predict lymph node metastasis. In this study, the LASSO method was used to effectively screen the optimal CT radiomics features of patients with non-small cell lung cancer before treatment, which can clearly identify that the CT radiomics features of different time periods can scientifically evaluate and examine the radiotherapy effectiveness of non-small cell lung cancer. This study conducted a scientific and reasonable analysis of the optimal imaging features of patients during the plain scanning, arterial, and venous phases, and obtained radiomics signature for patients in the training and validation groups. It was clarified that the independent risk factors for radiotherapy efficacy in patients include CEA, IDO, and radiomics signature.

Based on the above content, it can be concluded that the radiotherapy effect of non-small cell lung cancer can be effectively evaluated by using models constructed based on CT radiomics features of different phases, which can effectively predict the treatment prognosis of patients and enhance the treatment effectiveness.

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