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Cone-beam CT Radiomics for Patients with Liver Tumors Treated by Stereotactic Body Radiation Therapy: a pilot study

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INTRODUCTION

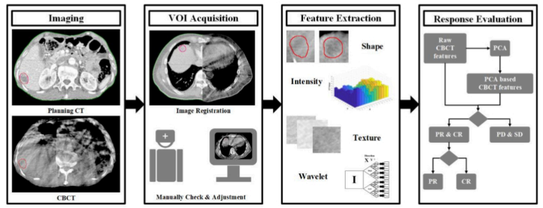
Liver cancer is the most common abdominal tumors, including primary hepatocellular carcinoma (HCC) and metastases from a variety of malignancies. Currently, stereotactic body radiation therapy (SBRT) has been shown effective in ablating liver tumors and metastasis. For patients treated with SBRT, it is important to assess the patient's treatment response for the clinicians to formulate a treatment plan after SBRT. In clinical settings the traditional treatment response evaluation method usually takes several months, which prevents a more timely response evaluation for patients with negative treatment responses, such as the Response Evaluation Criteria in Solid Tumors (RECIST) and modified RECIST. Previous study has shown that some cone-beam CT (CBCT) radiomics features are robust and can be reproducibly obtained from CBCT images [1], which provides an idea for the treatment response assessing of liver SBRT patients using existed CBCT images through radiomics.

AIM

In this pilot study, we investigated the interchangeability of liver planning CT (pCT) and CBCT extracted radiomics features firstly, then we analyzed the dynamic change of robust CBCT radiomics features during the course of treatment. Finally, we assessed the feasibility of using CBCT radiomics method to evaluate the treatment response for liver tumor patients who received SBRT.

METHOD

- The CBCT and planning CT (pCT) images of 36 liver cancer patients were prospectively included in this study. All the patients received five-fraction SBRT treatment within two weeks at our institution.
- Radiomics features were extracted from both CBCT and pCT. Pearson correlation test was used to select interchangeable CBCT radiomics features with pCT.
- All five fractions of CBCT radiomics features were reconstructed into five principle components using principle components analysis (PCA) to characterize therapy-induced tumor change.
- The Mann-Whitney U-test was used to select distinct features for predicting the treatment response (local efficacy vs local non-efficacy; complete response (CR) vs partial response (PR)) in both the raw and PCA-based CBCT radiomics features. The area under the ROC curve (AUC) was applied to assess feature performance.



RESULTS

- *A total of 345 CBCT radiomics features were found interchangeable with pCT (p-value<0.05). All the NGTDM features and shape features were interchangeable between CBCT and pCT with significant linear correlation. GLCM features in non-wavelet features and LHH features in wavelet features of CBCT were significantly correlated with that of pCT.*
- *The CBCT radiomics features showed good performance in predicting local efficacy (PR&CR vs PD&SD). In raw CBCT radiomics features, a total of 6 radiomics features from five-fractions CBCT images showed a significant difference between local efficacy and local non-efficacy patients (Figure 2a). The 6 features include 4 features from CBCT1 and 2 features from CBCT4. The CBCT radiomics feature CBCT1_ LHL_GLSZM_SZE had the highest AUC of 0.824 (0.680-0.968, 95% CI). For the PCA-based CBCT radiomics features, a total of 63 radiomics features showed a significant difference. The PCA-based feature PCA3_ LHH_Histogram_Energy had the highest AUC of 0.884 (0.773-1.00, 95% CI).*
- *For identifying PR patients from CR patients, 61 raw CBCT radiomics features and 42 PCA-based CBCT radiomics features had potential value. Among the 61 raw CBCT features, 8 features were from CBCT 1, 16 from CBCT 2, 16 from CBCT 3, 5 from CBCT 4 and 16 from CBCT 5. The ROC curves of the 61 raw and 42 PCA-based CBCT radiomics features were shown in Figure 2c and 2d, respectively. The LHL_GLSZM_GLV from CBCT2 (in the 2nd fraction) and the 4th PC of LHL_GLRLM_SRE showed the highest AUC in raw (AUC=0.879, 0.744-1.00, 95%CI) and PCA-based (AUC=0.871, 0.731-1.00, 95%CI) CBCT features, respectively.*

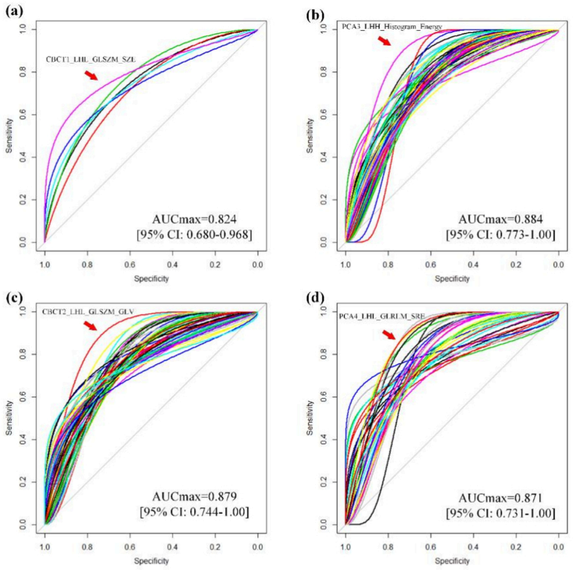


Figure note: ROC curves of CBCT based radiomics features for identifying treatment response: (a) raw CBCT radiomics features for classifying local efficacy and local non-efficacy patients; (b) PCA-based features for classifying local efficacy and local non-efficacy patients; (c) raw CBCT radiomics features for classifying PR and CR patients; (d) PCA-based features for classifying PR and CR patients;

CONCLUSIONS

- ***Both raw and PCA-based CBCT radiomics features showed good performance in identifying PR patients.***
- ***The capability of CBCT radiomics features in classifying patient treatment response showed the potential of adjusting patient treatment strategy before the end of SBRT.***

REFERENCES

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