Diagnostic Accuracy of $^{11}$C-Methionine PET for Differentiation of Recurrent Brain Tumors from Radiation Necrosis After Radiotherapy

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Abstract

We evaluated the diagnostic accuracy of PET with L-methyl-$^{11}$C-methionine ($^{11}$C-MET) for the differentiation of recurrent brain tumors from radiation necrosis. **Methods:** Seventy-seven patients who had been previously treated with radiotherapy after primary treatment for metastatic brain tumor ($n = 51$) or glioma ($n = 26$) were studied to clarify the diagnostic performance of $^{11}$C-MET PET in differentiating between recurrent brain tumors and radiation necrosis. A total of 88 PET scans with $^{11}$C-MET were obtained; sometimes more than one scan was obtained when there was an indication of recurrent brain tumor or radiation necrosis. A definitive diagnosis was made on the basis of pathologic examination for recurrent brain tumors and on the basis of pathologic examination or clinical course for radiation necrosis. Several indices characterizing the lesions were determined; these included mean and maximum standardized uptake values ($SUV_{\text{mean}}$ and $SUV_{\text{max}}$, respectively) and the ratios of lesion uptake to contralateral normal frontal-lobe gray matter uptake corresponding to the $SUV_{\text{mean}}$ and the $SUV_{\text{max}}$ ($L/N_{\text{mean}}$ and $L/N_{\text{max}}$, respectively). Receiver-operating-characteristic (ROC) curve analysis was used to determine the optimal index of $^{11}$C-MET PET and cutoff values for the differential diagnosis of tumor recurrence and radiation necrosis. **Results:** The values of each index of $^{11}$C-MET PET tended to be higher for tumor recurrence than for radiation necrosis. There were significant differences between tumor recurrence and radiation necrosis in all of the indices except for the $L/N_{\text{max}}$ for glioma. ROC analysis indicated that the $L/N_{\text{mean}}$ was the most informative index for differentiating between tumor recurrence.
and radiation necrosis. An L/N mean of greater than 1.41 provided the best sensitivity and specificity for metastatic brain tumor (79% and 75%, respectively), and an L/N mean of greater than 1.58 provided the best sensitivity and specificity for glioma (75% and 75%, respectively). **Conclusion:** $^{11}$C-MET PET can provide quantitative values to aid in the differentiation of tumor recurrence from radiation necrosis, although these values do not appear to be absolute indicators. Quantitative analysis of $^{11}$C-MET PET data may be helpful in managing irradiated brain tumors.

**Key Words:** $^{11}$C-MET, PET, radiotherapy, radiation necrosis