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Methionine positron emission tomography for differentiation of recurrent brain tumor and radiation necrosis after stereotactic radiosurgery —In malignant glioma—

Naohiro TSUYUGUCHI,*[1] Toshihiro TAKAMI,*[1] Ichiro SUNADA,*[2] Yoshiyasu IWAI,*[3] Kazuhiro YAMANAKA,*[3] Kiyoaki TANAKA,*[1] Misao NISHIKAWA,*[1] Kenji OHATA,*[1] Kenji TORII,*[4] Michiharu MORINO,*[1] Akimasa NISHIO*[1] and Mitsuhiro HARA*[1]

*[1]*Department of Neurosurgery, Osaka City University Graduate School of Medicine*
*[2]*Department of Neurosurgery, Saiseikai Ibaraki Hospital*
*[3]*Department of Neurosurgery, Osaka City General Hospital*
*[4]*Department of Nuclear Medicine, Osaka City University Graduate School of Medicine*

Object: Following stereotactic radiosurgery (SRS), we examined how to differentiate radiation necrosis from recurrent malignant glioma using positron emission tomography (PET) with ^{11}C-methionine (Met). ***Methods:*** Met-PET scans were obtained from 11 adult cases of recurrent malignant glioma or radiation injury, suspected on the basis of magnetic resonance images (MRI). Patients had previously been treated with SRS after primary treatment. PET images were obtained as a static scan of 10 minutes performed 20 minutes after injection of Met. We defined two visual grades (e.g., positive or negative Met accumulation). On Met-PET scans, the portion of the tumor with the highest accumulation was selected as the region of interest (ROI), tumor-versus-normal ratio (TN) was defined as the ratio of average radioisotope counts per pixel in the tumor (T), divided by average counts per pixel in normal gray matter (N). The standardized uptake value (SUV) was calculated over the same tumor ROI. Met-PET scan accuracy was evaluated by correlating findings with subsequent histological analysis (8 cases) or, in cases without surgery or biopsy, by the subsequent clinical course and MR findings (3 cases). ***Results:*** Histological examinations in 8 cases showed viable glioma cells with necrosis in 6 cases, and necrosis without viable tumor cells in 2 cases. Three other cases were considered to have radiation necrosis because they exhibited stable neurological symptoms with no sign of massive enlargement of the lesion on follow-up MR after 5 months. Mean TN was 1.31 in the radiation necrosis group (5 cases) and 1.87 in the tumor recurrence group (6 cases). Mean SUV was 1.81 in the necrosis group and 2.44 in the recurrence group. There were no statistically significant differences between the recurrence and necrosis groups in TN or SUV. Furthermore, we made a 2×2 factorial cross table (accumulation or no accumulation, recurrence or necrosis). From this result, the Met-PET sensitivity, specificity, and accuracy in detecting tumor recurrence were determined to be 100%, 60%, and 82% respectively. In a false positive-case, glial fibrillary acidic protein (GFAP) immunostaining showed a positive finding. ***Conclusion:*** There were no significant differences between recurrent malignant glioma and radiation necrosis following SRS in Met-PET. However, this study shows Met-PET has a sensitivity and accuracy for differentiating between recurrent glioma and necrosis, and presents important information for developing treatment strategies against post radiation reactions.

Key words: malignant glioma, recurrence, PET, methionine, stereotactic radiosurgery, radiation necrosis