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Acute effects of stereotactic radiosurgery on the kinetics of glucose metabolism in metastatic brain tumors: FDG PET study

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Hyperacute changes in the expression of glycolysis-associate gene products as well as FDG uptake in tumor cells after high-dose irradiation reflect response of the cells to noxious intervention and may be a potential indicator of the outcome of treatment. To understand acute effects on the kinetics of glucose metabolism of tumors *in vivo* after high-dose irradiation, we analyzed dynamic FDG PET data in patients with metastatic brain tumors receiving stereotactic radiosurgery. ***Materials and Methods:*** We studied 5 patients with metastatic brain tumors by means of dynamic FDG PET before and 4 hours after stereotactic radiosurgery. Rate constants of glucose metabolism ($K_1^* - k_3^*$) were determined in a total of 13 tumors by a non-linear least squares fitting method for dynamic PET and arterial blood sampling data. Rate constants after radiosurgery were compared with those before radiosurgery. Changes in the rate constants induced by the therapy were also correlated with changes in tumor size evaluated by CT and/or MRI 6 months later. ***Results:*** Four hours after radiosurgery, the phosphorylation rate indicated by k_3^* was significantly higher (0.080 ± 0.058) than that before radiosurgery (0.049 ± 0.023) ($p < 0.05$, paired t test), but there was no significant change in the membrane transport rates indicated by K_1^* and k_2^*. Although increases in the net influx rate constant K^* ($= K_1^* k_3^* / (k_2^* + k_3^*)$) were correlated with increases in k_3^*, K^* after radiosurgery (0.027 ± 0.011) was not significantly different from that before the therapy (0.024 ± 0.012). The reduction in the tumor size was correlated with k_3^* after radiosurgery. ***Conclusion:*** Acceleration of the phosphorylation process was demonstrated *in vivo* in metastatic brain tumors as early as 4 hours after stereotactic radiosurgery, as shown experimentally *in vitro* in a previous report. The phenomenon may be a sensitive indicator of cell damage.

Key words: PET, FDG, tumor, rate constants, radiosurgery