Cross-planar microbeam irradiation can improve survival rate of rats with C6 glioma

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Rationale and objectives

SPring-8 synchrotron X-ray beam facility at BL28B2 beamline was used to carry out a slit type microbeam treatment (MRT) on rats with brain tumor.

Methods

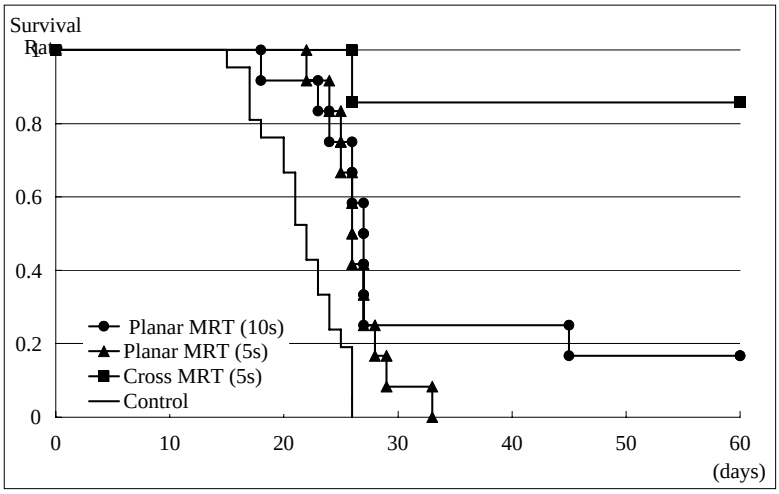
The beam was segmented using a mulislit collimator, 25 um width, spaced 200 um on center. The air kerma rate was measured with a free-air ionization chamber, which was found to be 140 Gy/s. C6 rat glioma cells (5 x 10^5 cell) were grafted into the striatum of adult Wistar rats and irradiation was done on day10 post-grafting. The irradiation area was 20 mm width and 15 mm vertical. The irradiation time was ranged between 0.1 sec to 10 sec. The tumor volume was histologically quantified on day10 post-irradiation. Immunohistochemical studies using anti-vimentin and GFAP were also performed on control non-grafted rats.

Results

Co-planar MRT (10 sec, n=5; 5 sec, n=5) and broad RT (0.1 sec, n=4) resulted in 75-88 % volume reduction of the control (non-irradiated, n=7). The mean survival rates of co-planar MRT showed dose dependent tendency; 31 days with 10 sec MRT (n=13), 26 days with 5 sec MRT (n=13), 19.3 days with 1 sec MRT (n=10). 5-10 sec irradiations were significantly effective in comparison with the control (21.3 days, n=22) or broad irradiation (0.1 sec, n=4). Cross-planar MRT (5 sec x 2) showed markedly prolonged survival (51.4 days, n=8). Brain section obtained 60 days post-MRT showed complete disappearance of the tumor mass, forming a large cavity in the striatum, and parallel or cross stripes in the surrounding normal brain. In rats irradiated with MRT, activated astrocytes were observed in the stripe pattern at only the exposed area, whereas activated astrocytes were observed all over the unirradiated part with broad RT. The changes of astrocytes were diminished along with time.

Conclusions

Cross-planar MRT markedly improved the survival rate of rats with C6 glioma in comparison with co-planar MRT.


Survival
Rate
1
0.8
0.6
0.4
0.2
0
Planar MRT (10s)
Planar MRT (5s)
Cross MRT (5s)
Control
0
10
20
30
40
50
60
(days)