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A BEAM-MODIFICATION ASSEMBLY FOR EXPERIMENTAL

NEUTRON CAPTURE THERAPY OF BRAIN TUMORS

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Recent attempts to treat intracerebral rat gliomas by boron neutron capture therapy (BNCT) have been somewhat disappointing^{1,2}, perhaps in part because of excessive whole-body and nasopharyngeal irradiation. Intracerebral rat gliomas were treated by BNCT with more success using a new beam-modification assembly [Fig. 1]. Rats were infused with the sulfhydryl borane dimer $\text{Na}_4^{10}\text{B}_2\text{H}_{12}\text{S}_2$ continuously for three days before irradiation. Concentrations of ^{10}B in their tumors had then reached the 30-40 $\mu\text{g/g}$ range³.

An 18 mm thick, 25.4 cm x 25.5 cm square ^6LiF powder/epoxy plastic (1:1 v/v) collimator was molded with a central 11.5 mm diameter therapy aperture at the apex of a truncated conical (30° half-angle) neutron-restrictive air column. The collimator was apposed to the 25.4 cm x 25.4 cm square bismuth plate at the face of the thermal neutron port of the Brookhaven Medical Research Reactor. Anesthetized rats were irradiated with their bodies supine in a 5.0 cm diameter cylindrical hole through an H_2O -filled, 25.4 cm x 25.4 cm square, 9.8 cm deep box with 18 mm-thick transparent Lexan plastic walls. Additional body shielding was provided by a 5.7-6.5 cm diameter, 8 mm thick, water-tight cylinder filled with ^6LiF powder. Rat heads were supported vertically in an adjustable TFE-Teflon gantry to center the tumors at the circular neutron aperture as illustrated [Fig. 1].

Preliminary dose measurements indicate that tumor thermal neutron fluences were $\approx 1 \times 10^{12} \text{ cm}^{-2}$. Whole-body irradiation doses from fast neutrons and gamma photons were $\approx 0.7 \text{ Gy}$ and $\approx 0.4 \text{ Gy}$, respectively. The results of this study, as indicated by median post-irradiation survival [Fig. 2], demonstrate that important parameters of BNCT for brain tumors can be evaluated in small animals in vivo. However, the feasibility of doing so is particularly dependent on an appropriate nuclide composition and a suitable configuration for each structure in the body radiation shielding of the beam-modification assembly.

The research described in this report involved animals maintained in animal care facilities fully accredited by the American Association for Accreditation of Laboratory Animal Care.

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Fig. 1 Anesthetized rat held supine in the body radiation shield of the beam-modification assembly. The gantry-supported head is photographed through a Lucite plate. This plate acts as a surrogate for the surface of the neutron collimator to depict the orientation of the rat head at the 11.5 mm diameter aperture of the collimator.

Fig. 2 Malignant gliosarcomas were initiated in the brains of 39 rats 14 days before the day of irradiation (middle and right bars) or before no treatment (left bar). The sulfhydryl borane dimer $\text{Na}_4^{10}\text{B}_{24}\text{H}_{22}\text{S}_2$ was infused into the peritoneal cavity at the rate of about 2 mg ^{10}B per kg body weight per hour for 72 hours before irradiation at the Brookhaven Medical Research Reactor.

MEDIAN SURVIVAL OF RATS WITH BRAIN TUMORS AFTER DAY OF IRRADIATION (days)