Intracavitary Irradiation of Malignant Brain Tumours*

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Undoubtedly, glioblastomas are a continuing discouraging problem. Surgeons have been content to remove the tumour incompletely and to resort to postoperative roentgen-ray therapy, which has not succeeded in destroying or restraining the residual tumour in any large degree. A few attempts have been made to increase the effective radiation by implantation of radon seeds or radium in the bed of the tumour, or by use of roentgen rays of high intensity directly in the operating room. Several long-term survivals have been reported with hemispherectomy, at a price, however, of severe neurological disability.

Beginning in 1953, a further attempt was made to destroy the residual tumour with the more potent sources of radiation then becoming available. The disturbing feature about these tumours is that a large proportion lie deeply within the hemisphere and have even crossed to the other side when the patient is first submitted to treatment. This paper does not deal with this type of case, but rather with those few cases in which the tumour is near the surface and can be tilted easily out of its bed and in which the residual tumour might reasonably be expected to be destroyed if enough lethal radiation was directed to it. With the introduction of a source of radiation into the cavity remaining after gross removal of the tumour, it was planned to localize very large doses of gamma radiation to the bed of the tumour in such a way that destruction of all residual tumour to a depth of 2.5 cm. might be nearly certain. The sites of tumour were selected so that necrosis of intact brain to this depth should not produce serious neurological deficit. A method of shielding was introduced to protect the bone flap and scalp.

Only a few isotopes could reasonably fulfill the requirements of high- to medium-average energy of radiation, high rate of dose, small size and availability. At the time, Iridium proved suitable except for a relatively short half-life of 74 days. It could be produced in the form of a small metallic disc, 3 mm. x 0.5 mm., with a high specific activity and emitting a large number of gamma rays of average energy of 300 KeV (Table 1).

It was possible to introduce directional radiation shielding, using mercury as absorber, by inserting the radioisotope into the centre of a hemispherical plastic applicator with a radius of 2 cm. The mercury shield (8 to 10 mm. thick) reduced the dose to the scalp and skull to about 1/10th of that delivered to the bed of the tumour. This design ensured that the dose 2.5 cm. from the surface of the applicator (and bed of the tumour) was about 20 per cent of the dose at the surface (Fig. 1). It was planned to give 5,000 r in 2 to 5 days at this depth, a presumed lethal tumour dose. The dose nearer the applicator was, of course, much greater, but a shallow layer of necrosis was to be accepted. At this rate of dose more eloquent areas of the hemisphere beyond 2.5 cm. from the applicator should have received amounts assumed to be within tolerance.

The applicator was placed in the cavity of the tumour at the initial (or subsequent) craniotomy and attached to the bone flap by means of a flange screwed to the shaft protruding through a central Burr hole (Fig. 2). After closure of the wound the source was quickly inserted into the central channel of the applicator through a short overlying incision in the scalp. At the end of the period of treatment the source alone was withdrawn.

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through the small incision, although removal of the applicator required a second craniotomy. Careful records were kept of the exposure of radiation to the Operating Staff during the procedure. Special nursing instructions and isolation of the patient resulted in keeping the dose to all personnel well below permissible limits.

Case Reports

Over a 3-year period, beginning in 1953, 6 patients were treated by this method. The doses are given in two figures representing the dose at the surface of the bed of the tumour and at a depth of 2.5 cm.; e.g., 20,000 r to 5,000 r. The procedure was tolerated well in each instance. Epilation was restricted to the region of the bone flap. Radiation sickness was not a feature.

Case 1. R.F., a boy aged 17 years, had a solid, well circumscribed, malignant astrocytoma removed from his left frontal lobe. A dose of 20,000 r to 5,000 r was given to the bed of the tumour over a period of 132 hours. He is in good health with no evidence of recurrence 8 years after this treatment.

Case 2. N.P. 451-57. R.T., a middle-aged farmer, had a large cystic tumour removed from his left frontal lobe less than 1 month after his first symptom. Histological sections showed the growth to be a malignant glioma. The majority of the tumour cells were astrocytes among which were multinucleated malignant giant cells. He was given only 10,000 r to 2,500 r over 40 hours into the tissue of the partially amputated left frontal lobe, because of the fear of damage from radiation to his anterior cerebral arteries and his left orbit. When the iridium applicator was removed a considerable amount of blood clot was found in the bed of the tumour which probably lowered the radiation to the residual tumour cells.

This patient survived only 5 months and post mortem the tumour, which had spread through the genu of the corpus callosum into the right frontal lobe (Fig. 3), was found to be almost completely necrotic. A few living residual tumour cells were found in the tissue of both frontal lobes. There was no necrosis from radiation in the white matter adjacent to this widespread necrotic tumour.

Case 3. N.P. 453-57. F.E., a man aged 37, was operated on 4 weeks after development of signs and symptoms of a tumour of the right frontal lobe. A glioblastoma multiforme was removed and

![Fig. 1. The iridium and caesium applicators. The diagram shows half of each applicator only, for comparison. Isodose curves are normalized to 100 per cent at 2½ cm. from source.](image)

![Fig. 2. The applicator attached to bone plate.](image)