Focal brain radiotherapy

"Radiosurgery", or as I propose, "focal radiotherapy", is the administration of a very high dose of ionising radiation with extreme accuracy to a small volume of tissue. Fast falling dose gradients at the periphery of the target result in the surrounding brain receiving very little dose. The combination of radiotherapy with stereotactically-directed delivery was described by Leksell in 1949. He modified the stereotactic instrument to accept a variable width collimator orthovoltage x-ray therapy apparatus. The lesion was placed at the centre and a large number of stationary portals was employed to deliver a large dose on a small target. There were dosimetric problems with the orthovoltage beam and subsequently a dedicated multiple beam cobalt-60 therapy unit was used. The 179 small cobalt-60 sources were distributed over part of the surface of a hemisphere: each source produced a finely collimated gamma beam directed toward the centre point of the hemisphere, where the lesion was placed by very accurately positioning of the patient. This Stockholm technique remains in use, using the more dosimetrically advantageous megavoltage photon beams, and similar units are being installed in several countries, including the Sheffield unit in Britain.

Recently it has become possible to achieve dose distributions similar to those of the Leksell system, by using megavoltage x-rays delivered from an isocranially mounted linear accelerator. This rotates in a series of arcs during treatment with the beam always pointing at the isocentre at which the lesion is positioned using a modified neurosurgical stereotactic frame. So called Stereotactic Multiple Arc Rotation Therapy (SMART) does not need general anaesthesia, allowing fractionated therapy. The technique may soon be available as an optional accessory to new radiotherapy accelerators.

Radiotherapy also encompasses the use of charged heavy particles. When these slow down in the tissues, ionising deposition occurs at the end of their path length. By adjustment of this Bragg peak phenomenon, lesions can be produced accurately at finite depths. Examples of this concept are the proton beam in Boston and the helium ion technique at Berkeley.

The various focal radiation methods are believed to be particularly useful in the management of arteriovenous malformations. A single dose of focal radiation causes, after a latency of six to 18 months, endarteritis obliterans in the majority of cases. It is important to encompass a complete nidus in the malformation and an advantage of the linear accelerator technique is that it will encompass lesions with diameters up to 3.5 cm, whereas with an external Leksell unit an upper limit of 18 mm is usual. Focal radiotherapy has also been used for intracranial neoplasms, although definitive evidence of the extent of its effect is not yet available. Lesions treated include choromas, local invasive meningiomas, and low grade discrete astrocytomas — either as a boost after conventional therapy or after recurrence.

The development of the linear accelerator method is likely to make stereotactically directed, highly focussed radiotherapy increasingly widely available. It may therefore be appropriate to refer to the technique not as radiosurgery but as focal brain radiotherapy. Although focal radiotherapy of the brain has few side-effects, Statham et al (June issue) described a patient who had necrosis in the epicentre of the radiation volume following cobalt-60 treatment. In their patient two adjacent volumes were irradiated and it is possible that the overlap predisposed to the occurrence of necrosis. This case is an apt reminder of the possibility of complications, and the care exercised by the pioneering groups remains essential in the safe and successful clinical application of the method.

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