

CyberKnife Radiosurgery for Arteriovenous Malformations: Series of 200 Patients

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Objectives: Since February 2003, we have used the CyberKnife System for treating arteriovenous malformations (AVMs) with a procedure that allows automatization.

Methods: Angiographic data are imported into the treatment planning by coregistering CT and 3D rotational angiography (3DRA). Radiological density of nidus vessels is determined first by placing a density evaluation cursor and moving it into the nidus volume. Delineation of AVM nidus contour is performed slice by slice on axial sections of 3DRA, employing the contouring function with an appropriate image density filter. Due to the high contrast of angiography images obtained by direct, intra-arterial contrast injection, target delineation can be completed automatically, under physician's supervision. With the same image fusion procedure, fMR can be employed for automatic contouring of cerebral critical regions that entail dose constraints. Once determined radiation dose to be delivered to the target volume and dose constraints to critical structures, inverse treatment planning function is utilized for calculating the treatment plan.

Results: CyberKnife radiosurgery has been employed in a series of 200 patients affected by cerebral AVMs. AVM nidus volume varied from 0.1 to 42 ml (mean 4.4 ml). Radiation doses employed ranged from 23 to 30 Gy (mean 25.2 Gy) and reference isodose from 70 to 85%. Single session irradiation has been performed in 180 pts. In 20 large (>8 ml) and/or critically located AVMs, prescribed radiation dose has been delivered in 2-4 fractions. One adverse effect of the irradiation procedure was observed (0.5% complication rate). Three bleeding occurrences have been observed so far in treated patients. Among 58 patients with target volumes < 8 ml and follow up > 24 months, angiographic obliteration (cure) has been obtained in 91%. The single spinal AVM treated was completely obliterated 36 months after CKS. This is also the single case in which complete obliteration has been obtained so far with a fractionated treatment.

Conclusion: We describe results obtained with a procedure that uses the CyberKnife inverse treatment planning in combination with different imaging modalities for automatic delineation of target and critical structures for treating AVMs. The procedure proved safe and contributed to the application of radiosurgery to more than 40 AVM patients that couldn't have been treated by other treatment modalities. Angiography-verified 24 months complete obliteration rate is higher than that previously obtained with our LINAC based isocentric technique.