Volumetric Analysis of Intracranial Arteriovenous Malformations Contoured for CyberKnife Radiosurgery with 3-D Rotational Angiography versus CT/MRI

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Categories: Neurosurgery

Keywords:

Abstract

Objective: We compare the nidal contouring of brain arteriovenous malformations (AVM) using fused images of contrasted computerized tomography (CT) and magnetic resonance images (MRI) with matched images of three-dimensional (3D) cerebral angiography for Cyberknife radiosurgery (CKRS) treatment planning.

Methods/Technique: Between May 2009 and April 2012, 3D cerebral angiography was integrated into CKRS target planning for thirty consecutive patients. The AVM nidal target volumes were delineated using fused CT and MRI scans versus fused CT, MRI, and 3D cerebral angiography for each patient, with the results directly compared and analyzed.

Results: The addition of 3D cerebral angiography provides superior visualization of the AVM nidus. The mean volume of the AVM nidus contoured with the addition of 3D cerebral angiography to the CT/MRI fusion (9.09 cm³, 95% CI 5.39–12.8 cm³) is statistically smaller than the mean volume contoured with CT/ MRI fused scans alone (14.1 cm³, 95% CI 9.16–19.1 cm³), with a mean volume difference of δ=5.01 cm³ (p=0.001). A diffuse AVM nidus is associated with larger mean volume differences in comparison to a compact nidus (δ=6.51 vs. 2.11 cm³, p=0.02). The mean volume difference is not statistically associated with the patient’s gender (male δ=5.61, female δ=5.06, p=0.84), prior hemorrhage status (yes δ=5.69, no δ=5.23, p=0.86), or prior embolization status (yes δ=6.80, no δ=5.95, p=0.11).

Conclusion: For brain AVMs treated with CKRS, the addition of 3D cerebral angiography to CT/MRI fusions for nidal contouring results in a statistically significant reduction in volume as compared to standard CT/MRI fusion-based contouring. Keywords: Arteriovenous malformation, AVM, 3D, Cerebral angiography, Contouring, Radiosurgery, Cyberknife