Risk of Hemorrhage Following Radiosurgery for Cerebral Arteriovenous Malformations (AVMs) Is Associated with Venous Stenosis

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Introduction

Approximately 6% of all patients who undergo radiosurgery experience subsequent hemorrhage, even in those with obliterated lesions. Little information has been presented in existing literature about risk modifiers of post-radiosurgery hemorrhage. Associated aneurysms, venous drainage pattern, size of AVM and prescription dose were previously reported as risk factors. Here, we aim to elucidate the effect of venous stenosis on risk of hemorrhage after radiosurgery.

Methods

We retrospectively reviewed medical records of all AVM patients evaluated at our institution from 1990-2015, and those who were treated with radiosurgery were included. We excluded patients without baseline or follow-up data, nor information about treatment and angiographic results. Baseline and angiographic characteristics were compared between those with venous stenosis and those without to elicit confounding factors. We then proceeded with univariable and multivariable Cox regression analysis looking at predictors of post-radiosurgery hemorrhage, with inclusion of confounding factors. Patients were censored from first radiosurgery to hemorrhage or to last follow-up.

Results

We included 240 patients in this study. Twenty-nine(12.1%) had venous stenosis; there were more AVMs with venous varices(p=0.009) and fewer with deep venous drainage(p=0.048) compared to those without venous stenosis. Univariable analysis on post-radiosurgery hemorrhage showed age, gender, AVM volume, venous stenosis, and unrelated aneurysm were associated with increased risk of hemorrhage. In an all-inclusive model multivariable Cox regression, increased risk of hemorrhage was associated with venous stenosis(HR:3.70, p=0.034), age(HR:1.05, p=0.002), AVM volume (HR:1.04, p=0.004), and hemorrhage before treatment (HR:4.11, p=0.014). Male gender appears protective (HR:0.31, p=0.036) against hemorrhage.

Conclusions

We found multiple factors associated with increased risk of AVM hemorrhage after radiosurgery. We recommend that selection of radiosurgery should proceed with caution with close follow-up after treatment, especially in patients with venous stenosis combined with advanced age, female gender, large AVM volume, and previous rupture.

Learning Objectives

By the conclusion of this session, participants should be able to:

1)Understand the benefits and limitations of radiotherapy for AVM treatment

2)Understand that stenosis of draining veins may indicate increased risk of AVM rupture

3)Understand the need for recognizing predictors of post-treatment hemorrhage