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INTRODUCTION: Remote cerebellar hemorrhage (RCH) is a rare phenomenon with only a few hundred cases reported in the literature. RCH is characterized by spontaneous bleeding in the posterior fossa following supratentorial craniotomy or spinal surgery. The cause of RCH is debatable, although a likely theory postulates that large CSF volume loss leads to "cerebellar sagging," creating changes in infratentorial venous blood pressure resulting in RCH.

METHODS: Seven cases of RCH following surgery were collected from the Rhode Island Hospital medical records from 2017–2019. Information on patient demographics, comorbidities, procedures, development of RCH, treatment, complications, and outcomes were collected. A literature review was completed on PubMed using the keywords "remote cerebellar hemorrhage" and "postoperative cerebellar hemorrhage."

RESULTS: The cases in this study suggest that CSF loss plays a direct role in the pathophysiology of a subset of RCH. Three of seven patients had postoperative changes in CSF dynamics. Of these, two were presumed to have CNS hypotension resulting from CSF leak after spinal surgery (lumbar fusion and thoracic laminectomy). One case involved VP shunt overdrainage which lead to RCH and required suboccipital craniectomy and adjustment of shunt settings. The other four patients without postoperative changes in CSF dynamics included patients who developed RCH following subdural hematoma evacuation. Three of these patients were asymptomatic and pursued no further treatment. One was symptomatic but the patient's family did not pursue further treatment due to the patient's age and comorbidities.

CONCLUSION: In summary, CSF dynamics seem to play a key role in the development of RCH. Our study provides further insight into this rare condition, and further studies are needed to better understand the underlying mechanisms of RCH and identify opportunities to prevent it.

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Stereotactic Radiosurgery for Hemorrhagic Symptomatic Cerebral Cavernous Malformations: An International Multicenter Study

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INTRODUCTION: Stereotactic radiosurgery has been used for treating cavernous malformation.

METHODS: Between 1988 and 2018, Gamma Knife® SRS was performed in 762 evaluable patients with symptomatic CCMs There were 262 (34%) CCM in the brainstem, 148 (19%) in basal ganglia or thalamus, and 372 (49%) in lobar locations. Most patients had experienced 2 or more hemorrhages associated with new neurological deficits. The median CM volume was 1.2 cm^3 (range, 0.01-28.9), and the median margin dose was 14.0 Gy.

RESULTS: After SRS, 158 patients (21%) had an imaging confirmed new hemorrhage at a median follow-up of 49 months. The hemorrhage-free survival after SRS for CCMs was 91% at 1 year, 86% at 3 years, and 81% at 5 years. The annual hemorrhage rate was 5.6% before and 0.3% after SRS. In univariate analysis, CM volume, brainstem or basal ganglia or thalamus, and increased number of hemorrhages before SRS was significantly associated with a higher rate of rehemorrhage after SRS. In multivariate analysis, number of prior hemorrhages ($P < .0001$, HR = 1.31, 95% CI: 1.19-1.47) and lower margin dose ($P = .03$, HR = 0.91, 95%CI: 0.85-0.97) were significant. Symptomatic adverse radiation effects (ARE) developed in 27 patients (3.5%).

CONCLUSION: Patients with an increased rate of hemorrhage before SRS had an increased risk of rehemorrhage. SRS has proven especially valuable in patients with deep seated, smaller CCM, and those with a smaller number of prior bleeds.

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FLAIR Hyperintense Vessels After Embolization of Brain Arteriovenous Malformations Predicts Delayed Intraparenchymal Hemorrhage

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INTRODUCTION: Delayed intraparenchymal hemorrhage(IPH) after treatment of brain arteriovenous malformations (AVM) is a well described complication. The underlying mechanism is likely associated with hemodynamic changes in perinidal tissue. So far, there is no established method to estimate the risk of post-treatment hemorrhage. FLAIR hyperintense vessels (FHV) are known to be associated with stagnant blood flow and may reflect hemodynamic changes after AVM treatment.

METHODS: We retrospectively reviewed the medical charts of all patients that underwent endovascular embolization of a brain AVMs from July 2017 - January 2020 at a single tertiary care center. Post-embolization MR images were evaluated for the presence of FHV and intraparenchymal hemorrhage.

RESULTS: In total, 50 patients underwent 75 sessions of embolization, and of those, 53 sessions received post-embolization MRIs. Post-embolization IPH occurred in 4 cases. FHVs were found in 100% of those cases (4/4) while only 7% of non-hemorrhage cases (2/28) demonstrated the presence of FHV ($P < .05$). Other factors associated with increased risk of delayed hemorrhage included multiple sessions of embolization and female sex ($P < .05$). Patency of the main draining vein, deep venous drainage, and Spetzler-Martin grade greater than 2 were not associated with increased risk of hemorrhage ($P > .05$).

CONCLUSION: Prior studies suggest that FHV likely represents stagnant or decreased cerebral blood flow. Here, we show that the presence of FHV is highly correlated with increased risk of post-embolization hemorrhage in the treatment of brain AVMs These preliminary results may improve our understanding of the complex pathophysiology of brain AVMs and aid practitioners in the post-operative care of these patients with the goal of minimizing the risk of delayed intraparenchymal hemorrhage.