Edaravone-Treated Patients Trend Toward Lower Incidence of DINDS

Effect of a Free Radical Scavenger, Edaravone, in the Treatment of Patients With Aneurysmal Subarachnoid Hemorrhage.

Munakata A, Ohkuma H, et al:

Neurosurgery 2009; 64 (March): 423-429

Edaravone might be proposed as a beneficial treatment option for aneurysmal SAH.

Background: Cerebral vasospasm following aneurysmal subarachnoid hemorrhage (SAH) is thought to be caused by the action of free radicals and oxidative stress following blood lysis and the release of oxyhemoglobin. Some suggest that free radical scavenging in the setting of SAH might decrease vasospasm and improve outcomes; several studies have assessed the effects of free radical scavengers in aneurysmal SAH. Some of these were shown to decrease delayed ischemic neurological deficits (DINDs) and improve outcomes, but they are not yet marketed. Edaravone is a free radical scavenger extensively used in Japan to ameliorate outcomes in acute ischemic stroke.

Objective: To assess the effects of edaravone in aneurysmal SAH.

Methods: Eligibility requirements included aneurysmal SAH within 48 hours of onset. SAH was diagnosed using CT and aneurysms using CT angiography. Data gathered encompassed Fisher grade at presentation and preoperative Hunt and Hess grade. Patients were randomly assigned to a control group or to an edaravone-treated group, with edaravone administered intravenously until postoperative day 14. Follow-up CT was done immediately postoperatively if new onset or exacerbation of neurological deficit occurred and at days 14 and 28 to assess for vasospasm-induced cerebral infarction, hydrocephalus, or other anomalies. The study primary end point was the incidence of DINDs; secondary end points were incidence of vasospasm-induced cerebral infarction and Glasgow Outcome Scale scores.

Results: Over a 3-year period, 111 patients with aneurysmal SAH were admitted (91 were enrolled and randomized; 42 to the control group and 49 to the edaravone group). The incidence of DINDs was 21% in the control and 10% in the edaravone group (difference not significant). Cerebral infarction occurred in 21% of control patients and 4% of edaravone patients (difference statistically significant). Among patients with DINDs, 67% had vasospasm-induced cerebral infarction versus none in the edaravone group (significant difference). At 3 months post-SAH, 83% of controls had favorable outcome and 17% had a poor or fatal outcome versus 92% and 8%, respectively, in the edaravone group (significant difference). Of the patients with poor or fatal outcome, 71% in the control group and none in the edaravone group had poor outcome caused by vasospasm (significant difference).

Conclusions: The edaravone group showed a trend toward a lower incidence of DINDs, but a significantly lower incidence of poor outcome caused by vasospasm. Edaravone might be proposed as a beneficial treatment option for aneurysmal SAH. A multicenter, placebo-controlled, double-blind study to validate these results will follow.

Reviewer’s Comments: Edaravone seems to offer promising results for treatment of aneurysmal SAH. However, other free radical scavengers (eg, tirilazad and nicaravin) showed promise in the experimental arena, but were later clinically deceiving. The multicenter study planned by the authors will likely help validate or refute the results herein. (Reviewer-Ziad A. Hage, MD).

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Keywords: Edaravone

Print Tag: Refer to original journal article
Angioplasty and stenting can reverse symptoms of mydriatic pupil and ipsilateral visual loss encountered with an ICA dissection.

**Background:** A usual presentation of cervical carotid artery dissection is Horner's syndrome, which is a combination of ipsilateral ptosis, miosis, and anhydrosis.

**Objective:** To report the atypical case of a patient with a mydriatic pupil as the presenting symptom of cervical carotid artery dissection. **Case Report:** A 49-year-old woman presented with isolated pupillary dilation along with intermittent transient monocular visual loss of the left eye. Transient speech abnormalities led her to seek medical advice. A plain head CT was unremarkable, but a CT angiography (CTA) of the head and neck showed a significantly flow-limiting left cervical internal carotid artery (ICA) dissection with poor collateral circulation. When examined, word finding difficulties were noted and visual acuity in the affected eye was 20/200 with moderate afferent pupillary defect that resolved upon blood pressure increase. The left pupil was dilated, tonic and minimally reactive, and pharmacological testing with pilocarpine confirmed denervation hypersensitivity of the iris. Extra ocular muscles were intact. The working diagnosis was pressure-dependent posterior ischemic optic neuropathy, as well as pressure-dependent ciliary ganglion dysfunction due to ophthalmic artery steal phenomenon. Angiography confirmed the left cervical ICA dissection and CT perfusion showed significantly diminished perfusion of the left hemisphere. Diffusion MRI showed punctuate infarcts of the boundary zone in the subcortical white matter of the left hemisphere, but did not demonstrate any infarcts in the brainstem that could explain the mydriasis. The patient was first treated medically with heparin, aspirin, plavix and mild induced hypertension, but no adequate response was noted. The patient then underwent angioplasty and stenting, which resulted in significantly improved flow in the left ICA and antegrade filling of the ophthalmic artery. Immediately after the procedure, the pupil returned to its normal size, and both pupils were equal and reactive. Acuity in the affected eye improved to 20/20. The patient was neurologically intact at her 1-month follow-up.

**Conclusions:** While unusual, a mydriatic pupil and ipsilateral visual loss can be the presenting symptoms in ICA dissection. The most likely explanation for these symptoms is ipsilateral ischemia of the ciliary ganglion and posterior ischemic optic neuropathy caused by dissection of the ICA. Angioplasty and stenting can be beneficial in this setting.

**Reviewer’s Comments:** These unusual symptoms are a rare and interesting presentation of a cervical ICA dissection. As mentioned by the authors, ischemia of the ipsilateral ciliary ganglion and optic nerve is the likely cause of these symptoms. Another reported cause of mydriasis in the setting of an ICA dissection is oculosympathetic excitation or spasm due to a sympathetic dysfunction. In this article, restoration of flow by angioplasty and stenting was able to reverse symptoms. However, this will not hold true in the setting of irreversible ischemia. (Reviewer-Ziad A. Hage, MD).

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Keywords: Carotid Artery Stenting

Print Tag: Refer to original journal article
The role of surgical therapy in treating patients with intracerebral hemorrhage is unclear and does not seem to improve outcomes in this heterogenous patient population.

**Objective:** The authors used a nationwide hospital database to identify recent therapy trends for patients with intracerebral hemorrhage (ICH), which is used to analyze effects of associated comorbidities and procedures, including surgery, in response to recently updated guidelines that have failed to reflect progress in the management of patients with ICH.

**Methods:** Data were obtained from the Nationwide Inpatient Sample hospital discharge database for 1993 to 2005, and reviewed retrospectively; multiple variables from patients identified as having been treated for ICH were analyzed statistically.

**Results:** Over the study period, the mortality rate (31.6%) and number of discharges were almost unchanged. Discharges to home declined by 25%, while non-home discharges doubled in frequency. Hospital length of stay (LOS) decreased by 30% as mean hospital charges roughly doubled. Longer hospital LOS was associated with onset of seizures; arterial hypertension was identified as a significant comorbidity. Surgical treatment was associated with a reduction of mortality, but with worse outcomes and lower rates of home discharge.

**Conclusions:** No significant progress was identified in the treatment or prevention of ICH over the study period. The role of surgical therapy is unclear and does not improve outcomes in this heterogenous population. No geographical differences in outcome were identified.

**Reviewer's Comments:** Despite improvements in neurocritical care, outcomes have not improved substantially over the past 30 years. Multiple studies have investigated the role of surgical therapy in these patients. Most notably, the Simplified Therapeutic Intervention to Control Hypertension (STICH) trial prospectively randomized patients to surgical or medical management and found no significant improvement in functional outcome, despite a reduction of mortality in the surgical subgroup. The findings of the current study reflect these results. A chief criticism of such studies is that patients with ICH represent an incredibly heterogenous patient population in terms of age, comorbidities, size and location of hemorrhage, and neurological symptoms. Post hoc analyses of the STICH data have identified subgroups of patients who may benefit from surgical intervention, namely patients with superficial lobar hemorrhages, and have led to further evaluation with the ongoing STICH II trial. There are other ongoing trials that will hopefully continue to provide information on the potential role of surgical intervention in the management of spontaneous ICH. Finally, this study provides a valuable analysis of the high costs associated with the treatment of ICH, particularly when it involves the treatment of patients who survive with significant disability. (Reviewer-Nicholas C. Bambakidis, MD).

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Keywords: Spontaneous Intracerebral Hemorrhage

Print Tag: Refer to original journal article
Use of recombinant factor VIIa (rFVIIa) is associated with reduced costs when used to correct coagulopathy in patients with TBI.

**Background:** Coagulopathy is associated with increased mortality in patients with traumatic brain injury (TBI). When present, coagulopathy prevents safe neurosurgical intervention. Recombinant factor VIIa (rFVIIa) has been used off-label to effectively and rapidly correct coagulopathy.

**Objective:** To determine if rFVIIa is clinically effective and cost-effective in the management of coagulopathic patients with TBI.

**Design:** Retrospective, single-institution, chart review.

**Methods:** Medical records were reviewed of all TBI patients with coagulopathy defined as an international normalized ratio (INR) ≥1.4, from 2002 through 2007. Neurosurgical management was protocolized, based on the Brain Trauma Foundation Guidelines. rFVIIa was used at the discretion of the treating physician and was not protocolized. Patients treated with rFVIIa to correct coagulopathy were compared to those who did not receive rFVIIa. Patients were stratified by ICU admission. Patients who died within 24 hours of admission, had nonsurvivable injuries, and had significant (Abbreviated Injury Scale [AIS]) >3 other body injuries were excluded.

**Results:** Of 2997 patients with TBI, 179 coagulopathic patients met inclusion criteria; 68 patients (38%) received rFVIIa and 111 (62%) did not. Patients who received rFVIIa had a higher Injury Severity Score (ISS) and higher INR. Higher percentages of rFVIIa patients had a head AIS score of 5 (compared to ≤4), greater frequency of neurosurgical procedures, and higher percentage of pre-injury warfarin. Total hospital costs were not different between groups. Hospital length of stay (LOS) and ICU-LOS were similar in both groups. Function outcome at discharge was better in the non-rFVIIa group. No difference in mortality (26.5% in rFVIIa vs 18.9% in non-rFVIIa) or thromboembolic complications (16.2% in rFVIIa vs 19.1% in non-rFVIIa) was present. The 110 patients who required ICU admission and received rFVIIa had lower costs, a shorter LOS, and less mechanical ventilator days than ICU non-rFVIIa patients. Functional outcome, mortality, and thromboembolic events were not different between ICU groups.

**Conclusions:** Coagulopathic patients with TBI treated with rFVIIa demonstrated greater cost-effectiveness of care with short hospital LOS and fewer days of mechanical ventilation with equivalent safety to other means of correcting coagulopathy.

**Reviewer's Comments:** This study demonstrates the improved cost-effectiveness of rFVIIa, with equivalent clinical efficacy in patients with TBI who require ICU admission. Of note, the use of rFVIIa was not standardized. However, it was used in patients with more severe brain injuries, a factor we should keep in mind. The retrospective nature of the study does not permit identification of the means by which rFVIIa is associated with shorter LOS and reduced ventilator time. Some may take issue with the study's definition of coagulopathy of an INR ≥1.4, but many neurosurgeons use this value as the level above which they wish correction. Based on the results of this study, I would consider using rFVIIa to correct coagulopathy in head-injured patients, particularly if urgent/emergent operative intervention is required. (Reviewer-N. Scott Litofsky, MD).

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Keywords: Traumatic Brain Injury

Print Tag: Refer to original journal article
The authors have presented convincing data that mechanical thrombectomy is cost-effective.

**Objective:** To evaluate the cost-effectiveness of mechanical thrombectomy versus best medical therapy for large-vessel ischemic stroke.

**Design:** Retrospective, case-control, cost-analysis from previously published data.

**Methods:** A Markov state-transition model was developed to compare thrombectomy to medical management of ischemic stroke presenting within 8 hours, but beyond the 3-hour window for IV thrombolysis. Inputs and ranges for the model, including rates of recanalization, symptomatic intracerebral hemorrhage (sICH) and clinical outcome, were based on data from the Mechanical Embolus Removal in Cerebral Ischemia (MERCI), the Pro-Urokinase for Acute Cerebral Thromboembolism (PROACT II), and the National Institute of Neurological Disorders and Stroke tissue plasminogen activator (NIHSD-tpA) trials. Economic data were compiled from various sources including Medicare and Current Procedural Terminology (CPT) code cost data for embolectomy and hospitalization. The costs and benefits measured in quality-adjusted life years (QALYs) associated with either treatment were compared using an incremental cost-effectiveness ratio (ICER): the difference in costs divided by the difference in QALYs. Univariate sensitivity analyses were illustrated for age, cost of embolectomy, recanalization rate, and annual cost of care for dependent patients.

**Results:** In a 67-year-old patient with large vessel ischemic stroke arbitrarily selected as the test case, medical therapy yielded 1.83 QALYs at a cost of $142,000, whereas thrombectomy generated 2.37 QALYs at a cost of $148,600, suggesting a gain of 0.54 QALYs at an increased cost of $6600 for thrombectomy, yielding an ICER of $12,120 per QALY gained. Univariate analysis of each variable demonstrated an ICER <$50,000 per QALY gained except for patients >82 years, where thrombectomy yields an ICER <$100,000 per QALY gained.

**Conclusions:** Mechanical thrombectomy resulted in 30% more QALYs than standard medical therapy across all ages tested.

**Reviewer's Comments:** The authors appropriately use a Markov model to demonstrate the cost-effectiveness of thrombectomy versus medical management in the treatment of large vessel ischemic stroke. The data utilized for model inputs is appropriate. The costs data were estimated from national average reimbursement for Medicare severity Diagnostic-Related Groups (DRGs) 023 and 024 (mechanical thrombectomy) and DRG 015 (medical management) plus the average professional fees, yielding appropriate cost-effectiveness conclusions for Medicare. However, since other third-party-payers often have different costs, it would be important to know how they compare to Medicare costs. The conclusions are limited by the purely historical data and hypothetical control group. A controlled-prospective trial using real costs data would provide stronger cost-effectiveness analysis, and the authors note that 2 such trials are underway. The authors have presented convincing data that mechanical thrombectomy is cost-effective. (Reviewer-Zoher Ghogawala, MD).

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Keywords: Mechanical Thrombectomy

Print Tag: Refer to original journal article
Neurosurgical Registrars Interpret CT Scans With Equivocal Results

Emergency Head CT Scans: Can Neurosurgical Registrars Be Relied Upon to Interpret Them?

Mukerji N, Cahill J, et al:

Br J Neurosurg 2009; 23 (April): 158-161

Neurosurgeons-in-training are able to provide accurate interpretation of normal CT scans and those with operative lesions, but perform less well with subtle abnormalities, such as cerebral ischemia.

**Background:** Neurosurgical registrars (equivalent to residents) are frequently requested to review CT scans of patients in the emergency department (ED). This practice is increasing with reduced threshold for ordering scans and less availability of attending radiologists on nights and weekends.

**Objective:** To determine the safety of neurosurgery registrar interpretation of CT scans by comparing their performance with radiologists' reports.

**Design:** Blinded prospective comparison.

**Participants/Methods:** 5 registrars independently evaluated consecutive CT scans ordered in the ED. Four of these same registrars subsequently evaluated an additional 150 scans. Scans were classified initially as normal or abnormal. If abnormal, the presence of hemorrhagic lesions, other mass lesions, cerebral ischemic changes, midline shift, loss of grey-white differentiation, signs of elevated intracranial pressure, fractures, and/or pneumocephalus was determined. Changes were classified as new or not new. Radiology reports were reviewed for the same features and compared with each registrar's interpretations by kappa analysis to determine the extent of agreement (0.7 was satisfactory concurrence).

**Results:** Radiology reports were available for 192 scans; 104 were normal and 88 were abnormal. Overall, 69% were reported by general radiology consultants, 18% by radiology registrars, 10% by reporting radiologists, and 3% by a neuroradiologist. Registrars 1 and 2 were in the second year of training, and registrar 3 was in the third year of training. For normal scans, 4 of 5 registrars had satisfactory agreement with radiology reports. On abnormal scans, registrars did not miss any fractures, intracranial mass lesions, or operative lesions. The most commonly registrar-missed abnormality was cerebral ischemia. When normal radiology reports did not agree with registrar interpretations, most often a finding of loss of grey-white differentiation (11) or elevated intracranial pressure (9) were not reported.

**Conclusions:** Neurosurgical registrars can be relied upon to interpret emergency head CT scans to diagnose surgical lesions, but not subtle abnormalities. Novel forms of image transfer should be considered to ensure that off-hours scans are reported by consultant radiologists.

**Reviewer's Comments:** This study has particular importance for neurosurgeons who work with neurosurgery residents-in-training. On the positive side, since junior neurosurgery residents are able to satisfactorily diagnose operative lesions on CT scans, attending neurosurgeons can have some confidence in their house staffs' clinical decisions with regard to the need for surgical intervention. On the negative side, the lack of concordance with regard to subtle abnormalities, such as ischemic disease, should raise concerns about the sufficiency of neuro-radiology training for neurosurgery residents, especially as neurosurgeons become more involved with endovascular care for cerebrovascular diseases. One should keep in mind that only a small number of registrars participated in the study and only a small number of scans were evaluated. A larger study is certainly warranted. Hospitals should make diligent efforts to ensure appropriate radiology attending coverage at all hours.  (Reviewer-N. Scott Litofsky, MD).

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Keywords: CT Scan Interpretation

Print Tag: Refer to original journal article
Elevated CRP and Long-Term Mortality After Ischemic Stroke

Elevated C-Reactive Protein and Long-Term Mortality After Ischaemic Stroke: Relationship With Markers of Endothelial Cell and Platelet Activation.
Shantikumar S, Grant PJ, et al:

Stroke 2009; 40 (March): 977-979

The significant correlation existing between CRP and post-stroke mortality may suggest inflammation-induced endothelial dysfunction and platelet activation as part of the underlying pathophysiology in stroke.

Background: Chronic inflammation has been identified as an important factor in the pathophysiology of atherosclerosis and ischemic stroke. It has been previously shown that C-reactive protein (CRP) levels are correlated with the risk of future cardiovascular thrombotic events in both healthy people and those with coronary artery disease (CAD). CRP has also been identified as a predictor of stroke, and in certain reports as a predictor of mortality after acute ischemic stroke (AIS). Other markers of inflammation, such as complement C3, have also been identified as predictors of cardiovascular events.

Objective: To determine the correlation between CRP and C3 and all-cause mortality after AIS.

Methods: Information regarding smoking status, history of stroke/transient ischemic attack (TIA), ischemic heart disease, peripheral vascular disease, diabetes mellitus, hypertension, and atrial fibrillation at presentation was recorded. Only patients surviving for >30 days following the ischemic insult were included. The study outcome was long-term mortality from all causes after AIS. A study of the correlation between CRP and C3 and mortality was performed using both univariate and multivariate analyses.

Results: 394 patients were included and followed for a median of 7.4 years, during which time, 59% died. CRP levels were significantly more elevated in patients who expired compared with survivors. C3 levels, however, did not differ between these 2 groups. Furthermore, increasing quartiles of CRP correlated with decreasing survival. This was not the case with C3. Moreover, a correlation between CRP and previously determined independent predictors of mortality, including advancing age, atrial fibrillation and previous stroke/TIA, was noted. An association was also found between increasing CRP quartiles and biochemical as well as hemostatic predictors of mortality, such as higher levels of creatinine, beta-thromboglobulin, and von-Willebrand-factor and lower albumin levels. Of note, the correlation between CRP and mortality was still valid after adjusting for age, atrial fibrillation, previous stroke/TIA, and stroke subtype.

Conclusions: Based on these results, the association between CRP and post-stroke mortality may suggest inflammation-induced endothelial dysfunction and platelet activation as part of the underlying pathophysiology in stroke.

Reviewer's Comments: While the results of this study are compelling, it is important to note that CRP is an acute phase reactant and thus may be affected by a variety of processes, including but not limited to infectious and other noninfectious inflammatory processes occurring in the body that may or may not affect stroke. Therefore, CRP is nonspecific for stroke, and using it to predict long-term mortality after AIS may not be accurate. Nonetheless, such studies are important to help shed further light on the pathophysiology of stroke and potentially find more specific markers to predict mortality. (Reviewer-Ziad A. Hage, MD).

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Keywords: Long-Term Mortality

Print Tag: Refer to original journal article
In this study, TDS correlated very well with CT in regard to assessing ICH within 6 hours of bleeding.

**Background:** Acute intracerebral hemorrhage (ICH) is associated with high morbidity and mortality. In patients presenting with ICH, initial ICH volume, decreased level of consciousness, and hematoma progression are predictors of poor outcome. Early detection of hemorrhage expansion can be helpful in determining which patients may need emergency pharmacological or surgical intervention. Transcranial duplex sonography (TDS) allows noninvasive visualization of acute ICH as a hyperechoic mass and also assesses intraventricular hemorrhage and midline shift. The advantage of TDS compared to CT and MRI, which are highly accurate imaging techniques, lies in the fact that it allows for concomitant assessment of brain hemodynamics and can be performed at the bedside.

**Objective:** To evaluate the efficacy of TDS compared to CT in measuring ICH volume and expansion in patients with supratentorial ICH within 3 hours of symptom onset.

**Methods:** All patients presenting with ICH within 3 hours of symptom onset were evaluated at the authors’ institution over a 1-year period. A CT scan and TDS were obtained at presentation and at 6 hours with no more than a 30-minute delay between tests. ICH volume on CT was calculated using this formula: (longitudinal x sagittal x coronal)/2. ICH expansion on CT and TDS was defined as >20% volume increase at 6 hours.

**Results:** 34 patients were assessed in this study. Early hemorrhage expansion at 6 hours was noted in 26%. When measured with TDS, mean ICH diameters did not significantly differ from those measured with CT. In fact, a statistically significant and excellent correlation was noted in regard to longitudinal and sagittal diameters when comparing both imaging modalities, as well as significant and good correlation in regard to coronal diameter. Moreover, a significant correlation was noted with ICH volume measurement and evaluation of early ICH expansion when comparing both techniques. Of all patients, only 1 had intraventricular hemorrhage, and TDS correlated well with CT.

**Conclusions:** TDS correlated very well with CT in assessing ICH within 6 hours of bleeding. TDS can, therefore, be a useful noninvasive technique to evaluate and follow early ICH at the bedside.

**Reviewer’s Comments:** This study demonstrates the usefulness of TDS in assessing and following ICH early. While CT and MRI are certainly more accurate, the benefits of using TDS can be noted when serial bedside follow-ups are needed. Undoubtedly, however, the initial imaging modality when ICH is suspected should be a CT scan. On the other hand, drawbacks of TDS include the facts that it is operator dependent and that certain lesions may not be visualized, depending on location, size, and suitability of the bone window. In fact, the authors report that 14 ICHs were missed in their study. Nonetheless, TDS can be added to the imaging armamentarium used to evaluate ICH. (Reviewer-Ziad Hage, MD).
The Utility of Quantitative Magnetic Resonance Angiography in the Assessment of Intracranial In-Stent Stenosis.
Prabhakaran S, Warrior L, et al:
Stroke 2009; 40 (March): 991-993

qMRA is a promising technique to screen for intracranial in-stent re-stenosis with high sensitivity and specificity.

Background: In-stent re-stenosis (ISR) is a known complication of intracranial stenting. Assessing ISR with noninvasive imaging such as CT and MRI is usually limited by artifact caused by the stent and/or coils. To circumvent that, digital subtraction angiography (DSA) has been used successfully. However, DSA is associated with a 1% complication risk, and the development of a noninvasive but reliable imaging technique to detect ISR is desirable. Quantitative magnetic resonance angiography (qMRA) visualizes vascular anatomy by combining the use of time-of-flight and phase-contrast MRI. Several reports have validated the usefulness of qMRA for blood flow measurement during workup of vertebrobasilar insufficiency, in extracranial-intracranial (ECIC) bypass surgery, and following Wingspan stenting. However, no studies exist regarding the use of qMRA to identify ISR.

Objective: To test the hypothesis that qMRA could noninvasively detect angiographic ISR.

Methods: In this retrospective review, all patients meeting the following criteria were included: stenting for cerebral aneurysms or intracranial stenosis; qMRA done within 1 year after stenting; follow-up angiogram done within 1 month of qMRA; and high-quality qMRA devoid of motion artifact. Demographic, clinical, and imaging information was gathered from patients' records. Noninvasive optimal vessel analysis (NOVA) was used to assess 2 cutoffs to define low flow by qMRA: >15% and >20% flow reduction. The Fisher exact test was used to study the correlation between both cutoffs and >50% stenosis by DSA.

Results: 14 patients were enrolled. A neuroform stent was used in 13 patients with wide-necked intracranial aneurysms, and a Wingspan stent was used in 1 patient with atherosclerotic stenosis. Lesion location was the intracranial carotid artery in 57.2%, the middle cerebral artery in 14.3%, and vertebrobasilar arteries in 28.6%. Median time from stenting to qMRA was 192 days, and time between angiogram and qMRA was 0.5 days. Follow-up DSA revealed 2 patients with >50% ISR. None were identified using time-of-flight MRA due to artifact. More than 15% decreased flow per qMRA did not significantly correlate with >50% angiographic ISR; however, >20% decreased qMRA flow did correlate. Using the >15% flow-reduction cut-off, the rates of sensitivity, specificity, positive-predictive value, and negative-predictive value of qMRA to detect >50% angiographic ISR were 100%, 75%, 40%, and 100%, respectively. Using the >20% flow-reduction cut-off, the rates of sensitivity, specificity, positive-predictive value, and negative-predictive value were 100%, 92%, 67%, and 100%, respectively.

Conclusions: qMRA is a promising technique to screen for intracranial ISR with high sensitivity and specificity. A larger prospective study is warranted.

Reviewer's Comments: As mentioned by the authors, NOVA and qMRA are very useful when assessing patients in need of ECIC bypass surgery, whether for preoperative planning or for postoperative bypass surveillance. It can also be very beneficial for the evaluation of vertebrobasilar and carotid insufficiency. In fact, we routinely use NOVA/qMRA for these indications at the University of Illinois with excellent results. Moreover, this study emphasizes another area in which NOVA/qMRA can be beneficial. Indeed, the possibility of detecting ISR noninvasively is highly appealing. A larger prospective study is warranted to further validate these results. (Reviewer-Ziad Hage, MD).

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Keywords: Blood Flow

Print Tag: Refer to original journal article
Follow-Up Head CT Needed After Mild Head Injury

Necessity of Repeat Head CT and ICU Monitoring in Patients With Minimal Brain Injury.
Bee TK, Magnotti LJ, et al:

J Trauma 2009; 66 (April): 1015-1018

Patients with mild head injury should have a follow-up head CT within 24 hours of injury because they have a relatively high risk of developing worsened CT findings or clinical examination that may warrant neurosurgical intervention.

**Background:** Patients with minimal brain injury (MBI), defined as loss of consciousness and/or retrograde amnesia with Glasgow Coma Scale (GCS) score of 14 and 15, constitute many admissions to monitored beds in trauma centers. Repeat head CTs within 24 hours may be an unnecessary use of scarce health care resources.

**Objective:** To determine if repeat head CT scans and ICU admission are unnecessary in patients with MBI.

**Design:** Single-institution retrospective review.

**Methods:** Trauma registry and medical records of patients with MBI and abnormal head CT after blunt trauma from 2005 to 2007 were reviewed. Patients with follow-up head CT between 12 and 24 hours after injury and ICU admission for no other reason were included for analysis. Patients with worsened CT findings or clinical exam were compared to patients without worsening.

**Results:** 207 of 8890 blunt trauma patients (average age, 46 years) met inclusion criteria. Of these patients, 63% had solitary lesions on head CT, and 37% had multiple lesions; 58 patients (28%) developed worsened follow-up head CT or clinical examination. No differences in age, type of injury, and blood pressure were found between groups. Head Abbreviated Injury Score and Injury Severity Score were higher in the worsening group. Patients with worsening had longer ICU stays than did non-worsening patients (5 vs 2.7 days). Patients with multiple lesions were more likely to worsen. Worsening patients required rehabilitation disposition more often and home discharge less often. Eighteen worsened patients (31%) required craniotomy (12) or intracranial pressure monitor placement (6).

**Conclusions:** Follow-up head CTs are beneficial in patients with MBI and may lead to decisions for neurosurgical intervention. These patients should be monitored in an ICU until imaging and clinical exams stabilize.

**Reviewer's Comments:** The authors reject their hypothesis that follow-up head CT and ICU admission for patients with MBI are unnecessary. The conclusions notwithstanding, the paper's methodology could be better. MBI is a misleading term and is not used by neurosurgeons; patients with a GCS of 13 to 15 have "mild head injury." The authors did not clarify if patients had CT or clinical worsening, but rather grouped these patients together, which makes interpretation cloudy. The authors also did not clarify ICU admission criteria, so the paper does not address that particular resource utilization well. Previous studies have documented the issue of patients presenting with mild head injury who deteriorate—hence our current practice of recommending follow-up head CT within 24 hours. Despite the scarcity of the resource, the consequences of significant patient deterioration can be profound. Since 28% of patients in this study developed either worsening head CT or worsening clinical examination and 31% of these required neurosurgical intervention, I strongly agree that follow-up head CT is appropriate for this group of patients. (Reviewer-N. Scott Litofsky, MD).

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Keywords: Repeat Head CT

Print Tag: Refer to original journal article
Quantitative MRA in Bilateral Vertebral Artery Occlusion


Starke RM, Chwajol M, et al:

Neurosurgery 2009; 64 (April): E779-E781

Along with cerebral angiography, quantitative MRA may provide important information on hemodynamics regarding diagnosis, preoperative planning, and follow-up assessment.

**Background:** Quantitative magnetic resonance angiography (MRA) has been proposed as a tool to assess flow for various cerebrovascular pathologies. Screening, perioperative, and surveillance indications have been discussed but not yet validated.

**Objective:** In this case report, Starke et al. illustrate the potential of this technology to enhance decision making and postoperative assessments in patients who may benefit from cerebral revascularization procedures. **Case Report:** A 39-year-old man presented with mild dizziness and vertigo, which progressed to include imbalance and diplopia. A diagnosis of bilateral vertebral artery occlusion was made on quantitative MRA and confirmed with cerebral angiography. Quantitative MRA demonstrated diminished and reversed blood flow in the basilar artery above and below the anteroinferior cerebellar arteries. It was decided to perform a left occipital artery to posterior inferior cerebellar artery bypass. Postoperative quantitative MRA demonstrated adequate revascularization with antegrade flow in the basilar artery. Angiography confirmed these findings. The patient's symptoms resolved and were intact on 6-month follow-up examination.

**Discussion/Conclusions:** Decision making in patients with hypoperfusion of the brain due to vascular occlusion is challenging due to imperfect diagnostic tools. It makes intuitive sense that quantifying cerebral blood flow could help refine revascularization strategies for such patients. Quantitative MRA allows for simple noninvasive quantification of cerebral blood flow with directional information. The authors illustrate the utility of this technology in a patient with vertebrobasilar insufficiency. The authors conclude that quantitative MRA along with cerebral angiography are beneficial and complementary in diagnosis, treatment planning, and follow-up of patients with vertebrobasilar insufficiency.

**Reviewer's Comments:** Quantitative MRA is a welcome tool in the neurovascular surgery armamentarium. I can think of many disease processes that can be better understood, monitored, and treated with the assistance of this technology, including intracranial atherosclerosis, stroke, vasospasm, and possibly arteriovenous malformations. Further studies are needed to validate this technology for procedural decision making, but the preliminary reports (including this one) are very promising. (Reviewer-Bernard R. Bendok, MD).

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Keywords: Blood Flow/Bypass

Print Tag: Refer to original journal article
AVMs with previous rupture and large size, as well as with infratentorial and deep locations, have the highest risk of subsequent hemorrhage.

**Background:** Arteriovenous malformations (AVMs) of the brain are congenital vascular lesions that account for approximately 2% of all hemorrhagic strokes. AVM is a relatively rare disease with an estimated current detection rate of approximately 1 per 100,000 person-years. The complex cerebrovascular anatomy of AVMs makes them a challenge to treat, and the treatment carries significant risks. To evaluate the possible benefit of a risky treatment, one needs to understand the natural history and prognosis of the disease.

**Methods:** The authors extended the largest series on natural history of AVM published by Ondra et al. in the *Journal of Neurosurgery* to 1990 to include 238 patients. All 631 consecutive patients with AVMs who were admitted to the Department of Neurosurgery at Helsinki University Central Hospital from 1942 to 2005 were identified. A diagnosis of AVM was based on angiography or histology. An AVM was considered ruptured before admission if there were signs of bleeding on a CT or lumbar puncture or a history of severe, sudden headache and bleeding was not ruled out. All available follow-up data were collected starting from admission until death or the end of 2005. A total of 631 AVM patients were admitted between 1942 and 2005; 393 patients had <1 month of hemorrhage- and treatment-free follow-up. The mean follow-up was 13.5 years (range, 1 month to 53.1 years). Complete follow-up was obtained for all but 3 (1.3%) patients. AVMs had ruptured in 139 patients before admission.

**Results:** During the total follow-up period of 3222 person-years, 77 patients experienced a hemorrhage from AVM resulting in an overall annual rupture rate of 2.4%. The risk of a new hemorrhagic event was highest during the first few years after diagnosis, and was almost 3 times higher during the first 5 years (4.6%) than thereafter (1.6%).

**Conclusions:** Results from this extensive natural history follow-up study in AVM patients to date indicate that previously ruptured, large, and infratentorially and deeply located AVMs have the highest risk of future hemorrhage. This risk is highest during the first few years after diagnosis and decreases thereafter, but remains significant for decades.

**Reviewer’s Comments:** AVMs of the brain account for approximately 2% of hemorrhagic groups, but this percentage approaches 50% in the young population in whom the consequences are most devastating. Although this study revealed a 2.4% annual hemorrhage risk from AVM, it does not reflect the risk in patients with multiple bleeds, which was accounted for in the original population by Ondra et al. If I am to quote a risk, I would use a range of 2% to 4% annual hemorrhage risk, knowing that this risk might be significantly different based on morphology and location. (Reviewer-Joseph Adel, MD).

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