Surveillance Imaging for Cerebellar Astrocytoma May Not Be Necessary

Postoperative Surveillance Magnetic Resonance Imaging for Cerebellar Astrocytoma.

Vassilyadi M, Shamji MF, et al:


Patients with complete resection of pediatric cerebellar low-grade astrocytomas do not have recurrence documented by surveillance MRI.

**Background:** For patients with pediatric cerebellar tumors, surveillance neuroimaging is performed to identify early recurrent or progressive disease with the expectation that subsequent intervention leads to improved outcome. Timing of surveillance is controversial.

**Objective:** To define the utility of applying a surveillance neuroimaging strategy in pediatric patients with low-grade cerebellar astrocytomas.

**Design:** Single institution, retrospective case series.

**Methods:** Pilocytic or non-pilocytic (diffuse, fibrillary, unspecified low-grade) astrocytomas were identified from medical records and histopathology of patients undergoing surgical treatment of posterior fossa brain tumors between 1987 and 2007. The extent of surgical resection was defined as total or subtotal on the basis of contrasted-enhanced MRI. Progression was defined as residual lesion enlargement in 3 dimensions compared to previous study. MRI results were reported either as negative if no recurrent disease for total resection or no progression for subtotal resection; alternatively, MRI was positive. Negative MRI string (NMS) ratio was calculated as total number of years of negative MRI (no recurrence or stable residual) as a fraction of the total years of follow-up.

**Results:** 15 cerebellar pilocytic astrocytoma patients and 13 non-pilocytic low-grade astrocytoma patients (average age, 7 years) had 34 craniotomies and 216 surveillance MRIs. Total resection was achieved in 73% of pilocytic astrocytoma patients and 62% of non-pilocytic astrocytoma patients. Of the 146 surveillance MRIs, 51% of patients required general anesthesia during average follow-up of 7 years. All studies were negative for recurrence, with a NMS ratio of 1.0. Subtotal resection was achieved in 27% of pilocytic astrocytoma patients and 38% of non-pilocytic astrocytoma patients. Of the 70 surveillance MRIs, 36% of patients required general anesthesia during a follow-up average of 4.4 years. NMS ratio was 0.75 for pilocytic tumors and 0.8 for non-pilocytic tumors. Five total resections were performed in reoperations for 6 initial subtotal resection patients.

**Conclusions:** Surveillance neuroimaging may be unnecessary in pediatric patients with pilocytic or non-pilocytic cerebellar astrocytomas who have had gross and radiological total resection. (Reviewer-N. Scott Litofsky, MD).

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Keywords: Pediatric, Pilocytic Astrocytomas, MRI

Print Tag: Refer to original journal article
Resecting Tumor When Smaller May Decrease Risk of Malignant Transformation

Recurrence and Malignant Degeneration After Resection of Adult Hemispheric Low-Grade Gliomas.

Chaichana KL, McGirt MJ, et al:

J Neurosurg 2010; 112 (January): 10-17

For every centimeter increase in tumor size, patients have a 1.3-fold increase in tumor recurrence risk after resection and a 1.1-fold increase in malignant conversion risk.

Objective: To evaluate factors associated with recurrence or transformation of low-grade primary tumors.

Participants/Methods: 191 patients with World Health Organization Grade II gliomas, who underwent surgical resection, were retrospectively analyzed. Tumor recurrence was defined as any evidence of recurrence or growth by imaging studies. Malignant degeneration was defined as an "increase in tumor contrast enhancement and/or a histopathologically proven malignant degeneration." Gross total resection (GTR) was defined as no residual FLAIR abnormality on postoperative MRI within 48 hours.

Results: Equal portions of the study group had fibrillary astrocytomas and oligodendrogliomas (47%), with 7% mixed gliomas. GTR was achieved in 36%. Eight percent received radiation therapy. Over a mean follow-up time of 36 ± 11 months, 43% of the tumors recurred and 23% underwent malignant degeneration with a median recurrence time of 28 months and a median malignant degeneration time of 32 months. Univariate analysis showed that Karnofsky Performance Scale (KPS) score ≥80, duration of the longest lasting symptom, preoperative motor deficits, tumor size, contrast enhancement, and gross total resection were associated with recurrence and progression; however, radiation therapy, pathology, seizures, and location were not. In multivariate analysis, factors associated with recurrence were the duration of the longest lasting symptom, tumor size, and preoperative contrast enhancement; size ≥3 cm was most significant (and more often GTR). For every centimeter increase in tumor size, patients had a 1.3-fold increase in tumor recurrence risk.

Univariate analysis of malignant degeneration showed the factors of age, preoperative motor deficits, tumor size, GTR, and radiotherapy associated, but not KPS, duration of symptoms, seizures, enhancement, or tumor location. In multivariate analysis, factors of significance were fibrillary astrocytoma pathology, tumor size, and GTR, with ≥3 cm tumor size having the greatest significance. For every centimeter increase in tumor size, there was a 1.1-fold increase in malignant degeneration risk. GTR held a 1.9-fold decreased chance of malignant degeneration.

Conclusions: The authors emphasize the effect of tumor size on recurrence and progression, which supports the contention that resecting the tumor when it is smaller may decrease the risk of malignant transformation. Low-grade enhancing tumors may behave more aggressively and may benefit from more aggressive treatment.

Reviewer's Comments: This study supports the association between the extent of resection and survival perhaps through decreased risk of malignancy and delay of recurrence. The decreased malignant degeneration with GTR does not necessarily support that an incomplete resection is of benefit to survival, as degree of resection was not studied. The proportion receiving radiation therapy was small, 8%, which may obscure an effect of that treatment. Other limitations of this study include the short 36-month mean follow-up, and that recurrences were not consistently biopsied. Therefore, a patient with simply an increase in enhancement may be defined as having malignant degeneration but may have had progression of the same tumor type. (Reviewer-Paul L. Penar, MD).

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Keywords: Surgical Resection, Survival, Astrocytoma, Oligodendroglioma, Malignancy, Recurrence

Print Tag: Refer to original journal article
If a spinal CSF leak is found in an anticoagulated patient presenting for chronic subdural hematomas, a spinal blood patch without surgery can be curative.

**Background:** The underlying cause of bilateral subdural hematomas in patients taking anticoagulants is often unclear. Over the past 7 years at Cedars Sinai Medical Center, 2% of the patients treated for cerebrospinal fluid (CSF) leak were taking warfarin and presented for nontraumatic subdural hematomas. The history or MRI of the brain was suggestive of a spinal CSF leak.

**Objectives:** To review the diagnosis, treatment, and follow-up of 3 anticoagulated patients with CSF leaks presenting with bilateral subdural hematomas.

**Design:** Single institution, retrospective study with a follow-up period of 3 to 6 months.

**Participants/Methods:** 3 older anticoagulated patients (68 to 86 years old) were admitted for acute neurological symptoms. All were initially imaged with a CT scan of the head and later with a head MRI and a CT-myelogram. The diagnosis of spontaneous spinal CSF leak was based on criteria previously published by the same group (*AJNR Am J Neuroradiol* in May 2008). In short, a CSF leak is either established on CT-myelogram or because of signs of hypotension on head MRI combined with a low opening pressure or meningeal diverticulum or symptoms improving after blood patch. In some cases, neither a CSF leak is found on CT myelogram nor signs of hypotension on head MRI. The authors then propose that the combination of 2 of the following symptoms and signs are sufficient to make the diagnosis: (1) characteristic positional headaches; (2) opening pressure < 6 cm H₂O; (3) spinal meningeal diverticulum; and (4) reduction of symptoms after epidural blood patching.

**Results:** In all patients, the symptoms resolved after epidural blood patch or fibrin glue patch (third patient), and the MRI normalized.

**Conclusions:** In patients treated with anticoagulants presenting with spontaneous chronic subdural hematomas, if the history includes symptoms of positional headaches or the MRI shows signs of cranial hypotension, further investigation is warranted to rule out a spinal CSF leak.

**Reviewer's Comments:** I have seen firsthand the marked improvement after blood or fibrin patch in patients with spinal CSF leaks. The point made here is that in anticoagulated patients presenting with chronic subdural hematomas, a craniotomy or burr holes might not be the right treatment. The 3 patients described in this article probably represent an underestimate of the actual number of chronic subdural hematomas due to CSF leak. One would hope that the group at Cedars will follow-up with another series in which the incidence of spinal CSF leak will be reported for all anticoagulated patients presenting with chronic subdural hematomas. Finally, it would be useful if a longer follow-up for these patients is published in order to assess the long-term risk of recurrence after blood patch. (Reviewer-Luc Jasmin, MD).

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Keywords: Intracranial Hypotension, Headaches, Subdural Fluid Collection, Warfarin, Spinal CSF Leak

Print Tag: Refer to original journal article
Subarachnoid hemorrhage patients with symptomatic vasospasm who do not clinically improve early on to hypertensive hypervolemic therapy have a higher risk of death or disability and should be considered for urgent endovascular-therapy.

**Background:** Subarachnoid hemorrhage (SAH) is often complicated by symptomatic vasospasm, which has been associated with decreased cerebral blood flow (CBF), cerebral oxygen-carrying capacity, and brain-tissue oxygen levels.

**Objective:** To assess the association between early clinical response to HHT in patients experiencing symptomatic vasospasm and new stroke on CT as well as death or severe disability at 3 months.

**Participants/Methods:** Over a 6-year period, 580 consecutive spontaneous SAH patients were admitted at the authors’ institution. Patients were treated with IV fluids to keep central venous pressure ≥5 mm Hg. Clinical improvement was defined as a 1-point increase in the Glasgow Coma Scale motor/verbal subscore or the Medical Research Council motor score. Survival and functional outcome were evaluated at 3 months with the modified Rankin Scale (mRS), and poor outcome was considered as death or severe disability (mRS score, 4 to 6). Cognitive function was measured using the Telephone Interview of Cognitive Status.

**Results:** 580 patient had spontaneous SAH of which 95 (16%) had symptomatic vasospasm and were included. Factors significantly correlated with higher symptomatic vasospasm occurrence were higher admission blood pressure, poor Hunt-Hess grade, and thicker SAH clot on admission CT. Of symptomatic vasospasm patients, 94% had hypervolemia treatment and 43% improved clinically. Hypertensive therapy was given in 85% and 68% responded clinically. Twenty-seven patients (30%) underwent balloon angioplasty of which 81% clinically improved; 76% had not responded to hypervolemia and 52% had not responded to hypertensive therapy. Of 95 symptomatic vasospasm patients, 26% died and 36% were dead or severely disabled at 3 months; 54% had vasospasm-related stroke. Neither hypervolemic therapy nor hypertensive therapy significantly influenced 3-month outcomes.

**Conclusions:** SAH patients with symptomatic vasospasm who do not clinically improve with HHT within 2 hours have a higher risk of death/disability and should be considered for urgent endovascular therapy.

**Reviewer's Comments:** This article reinforces what has been common practice in terms of management of vasospasm in patients with SAH. This article emphasizes the importance of the 2-hour window to reverse neurological deficits. In the event that patients fail to improve on HHT, endovascular options should be considered promptly to prevent ischemic events. (Reviewer-Ziad A. Hage, MD).

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Keywords: Angioplasty, Hypertensive Hypervolemic Therapy, Subarachnoid Hemorrhage, Vasospasm

Print Tag: Refer to original journal article
Dynamic plates show greater graft subsidence and loss of lordosis.

**Objective:** To compare the clinical and radiologic outcomes between fixed-hole and slotted-hole dynamic cervical plates for anterior cervical discectomy and fusion (ACDF).

**Design:** Retrospective review of clinical data.

**Participants/Methods:** 70 consecutive patients who underwent ACDF at a single institution by 1 of 2 surgeons between 2001 and 2005 were enrolled in this study. Indications for surgery were disk herniation or cervical stenosis causing radiculopathy and/or myelopathy. Fourteen patients were excluded because of inadequate follow-up. Therefore, data and radiographs were reviewed for 56 patients. Fibular allograft was used in all patients. The choice of the different dynamic plates was made according to surgeon preference. All patients were immobilized with a hard cervical collar for 6 to 8 weeks. Cervical x-rays were taken at 2 and 6 weeks after surgery, and then again at 3-month intervals. Criteria used to determine fusion were <3 mm motion in fusion construct on flexion and extension lateral radiographs, absence of a radiolucent gap between graft and the end plate, and the presence of a continuous bridge of bony trabeculae at the upper and lower ends of the graft. Clinical outcome was assessed using Odom's criteria.

**Results:** Patient demographics and clinical data did not differ significantly between groups. The average age was 51 years. The mean follow-up was 20.6 months. Significant differences between the 2 groups were found in graft subsidence and implant translation, which were higher in the slotted-hole dynamic plate group. Nonsignificant differences between the 2 groups were clinical outcome, pseudoarthrosis rate, and loss of lordosis, which was higher with slotted-hole plates.

**Conclusions:** Slotted-hole dynamic plates had a greater incidence of graft subsidence. Concerns are raised regarding multilevel ACDF with slotted-hole plates. In this study, the pseudoarthrosis in 3-level ACDFs was found only in the slotted-hole plate group. Slotted-hole dynamic plates also have a greater tendency for implant translation, which suggests that fixed-hole dynamic plates will be a better choice in multilevel cervical fusions. Also, to prevent encroachment of the adjacent disk spaces, special attention needs to be paid to the relationship of the screws to the adjacent vertebral body end plates.

**Reviewer's Comments:** This study is a retrospective review of one institution's experience with a sample size that may be too small to detect a significant difference in outcome. However, in a multicenter, randomized, controlled trial published in 2009, the authors still did not find a difference in clinical outcome. At this point, I consider implant translation especially problematic in multilevel ACDFs. Studies with longer follow-up need to show that the slotted-hole dynamic plate performs as well as fixed-hole plates and that the loss of lordosis does not become a problem later on. (Reviewer-Martina Stippler, MD).

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Keywords: Anterior Cervical Discectomy & Fusion

Print Tag: Refer to original journal article
If you decide to perform an anterior fixation of odontoid fractures in patients >70 years of age, use 2 screws.

**Objective:** To evaluate the fusion rate of anterior fixation of odontoid fractures in the elderly.

**Background:** In patients >60 years old, type II odontoid fractures are the most common type of cervical fracture. A high complication rate with external immobilization in patients >50 years old suggests that surgical fixation should be considered for functional patients. Because of immediate stabilization and preservation of a functional C1-C2 joint, odontoid screws have been used in younger patients routinely, but their success in the elderly has been questionable.

**Methods:** Over a 15-year period, 57 patients between the ages of 70 and 96 years were treated by direct anterior odontoid screw fixation. The follow-up ranged from 0 to 70 months, with a mean of 14 months. Fusion was confirmed with either bridging of trabecular bone across the fracture line or by lack of motion on flexion-extension radiographs despite the presence of a residual fracture line.

**Results:** 9% of the patients died during the perioperative period. All patients were neurologically intact and had either a type II or III odontoid fracture. One screw was used in 21 patients (37%), and 2 screws were used in the remaining 36 patients (63%). Chi-square analysis showed a significantly higher fusion rate in patients with 2 screws; 96% of patients with 2 screws had a stable fusion compared to 56% with 1 screw. At 3 months, bone union was seen in 57% of patients on their follow-up cervical spine x-ray. At 6 months, bone fusion was seen in 76%. Overall, 81% of these patients were stable radiographically at their last follow-up visit.

**Conclusions:** Anterior fixation of odontoid fractures in patients aged >70 years has an overall 81% rate of stable union. Two screws increased the fusion rate from 56% to 96%. Even in the elderly patient, anterior odontoid screw fixation seems to be an effective alternative to posterior arthrodesis.

**Reviewer's Comments:** Any external immobilization has a high morbidity and mortality rate in the elderly population. Therefore, one should not hesitate to offer surgical stabilization due to fear of postoperative complications. I don't agree with the authors that an anterior approach has less surgical soft-tissue trauma. In this case series, 25% of patients needed a feeding tube postoperatively. This speaks of additional surgical morbidity and risk that is not seen with a posterior approach. Posterior C1-C2 fusion in the experienced hands is a quick procedure with superior fusion rates to that of odontoid screws in any population. (Reviewer-Martina Stippler, MD).

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Keywords: Odontoid Screw, Anterior Fixation, Odontoid Fractures

Print Tag: Refer to original journal article
Salvage Procedure -- Balloon-Assisted Clipping of Large Paraclinoidal Aneurysm

Elhammady MS, Nakaji P, et al:

Neurosurgery 2009; 65 (December): E1210–E1211

Endovascular balloon inflation across the aneurysm neck can provide hemostasis as well as support for adequate aneurysm clipping in the setting of intraoperative rupture.

Background: Clip obliteration of paraclinoid aneurysms often necessitates temporary blood flow arrest to deflate the aneurysm and facilitate clip application. This can be achieved using temporary clips or suction decompression. Flow arrest can also be accomplished by endovascularly inflating a balloon across the aneurysm neck.

Objective: To describe the use of the latter technique as a rescue method during intraoperative aneurysmal rupture in the absence of proximal control. The balloon provides flow interruption as well as buttress for easier clip placement.

Case Report: A 45-year-old woman presented with Fisher 3 subarachnoid hemorrhage identified after a work-up of a severe headache. She had no neurological deficits but had positive meningeal signs. Digital subtraction angiography showed a 2-cm left paraclinoid aneurysm, and it was decided that microsurgical clipping would be the best treatment option. The aneurysm was exposed through a modified left orbitozygomatic approach, and the cervical internal carotid artery (ICA) was also exposed. It involved a major part of the ICA. After removal of the anterior clinoid process and exposure of the ophthalmic artery, temporary clips were applied on the cervical ICA, ophthalmic, and distal-ICA/posterior communicating artery. However, the aneurysm remained tense; therefore, direct suction decompression was performed using a 25-gauge needle. This softened the aneurysm and allowed its dissection from the optic-nerve. Placement of a right-angled fenestrated clip was then attempted multiple times but failed and occluded the parent artery due to aneurysm turgor. The common carotid artery was then temporarily occluded for more proximal control; however, the aneurysm ruptured at the neck when the clip was reapplied. Despite placement of a second clip, bleeding persisted. At this time, a balloon was endovascularly inflated across the aneurysm neck for proper control of bleeding and subsequent treatment. The bleeding was controlled with local tamponade, and groin access was obtained. A 4 x 10 mm balloon was then maneuvered through the left ICA, deployed across the aneurysm neck, and inflated, thus obtaining hemostasis. While the balloon was inflated, it acted as a mechanical buttress, and the clip was successfully used to completely occlude the aneurysm, including the neck tear. ICA occlusion time was 20 minutes. After balloon deflation, brisk flow through the ICA with complete aneurysm obliteration was noted. Postoperatively, the patient was right-sided hemiparetic, and an MRI showed inferior division left middle cerebral artery territory stroke. The angiogram showed no branch occlusion. She later underwent rehabilitation therapy and markedly improved.

Conclusions: Balloon inflation could provide hemostasis as well as support for adequate aneurysm clipping. This technique may be used as a rescue approach when proximal control is suboptimal in the setting of intraoperative rupture.

Reviewer's Comments: This article emphasizes the importance of both microsurgical and endovascular expertise when managing such complex aneurysms. Proximal control is key in treating these lesions, and the authors were prompt in using their technical skills to achieve hemostasis and clip the aneurysm while preserving the parent artery. This report demonstrates the usefulness of this approach in salvage situations; however, obtaining prior groin access is recommended. (Reviewer-Ziad A. Hage, MD).

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Keywords: Balloon-Assisted Clipping, Intraoperative Rupture, Paraclinoidal Aneurysm

Print Tag: Refer to original journal article
Can DBS Relieve Cluster Headache?

Safety and Efficacy of Deep Brain Stimulation in Refractory Cluster Headache: A Randomized Placebo-Controlled Double-Blind Trial Followed by a 1-Year Open Extension.

Fontaine D, Lazorthe Y, et al:

J Headache Pain 2010; 11 (February): 23-31

Problems in the design of the first randomized, double-blind study of unilateral hypothalamic stimulation for cluster headaches might explain why significance was not found.

**Background:** Clusters headaches are the most intense form of cranio-facial pain. Headaches are unilateral, of variable duration (15 minutes to hours), and described as intense as a hot poker being inserted in the eye or head. Autonomic symptoms are always present. Patients are often depressed and suicidal.

**Objective:** To establish that deep brain stimulation (DBS) could decrease the weekly number of cluster headache attacks.

**Design:** Multicenter, prospective, crossover, double-blind study.

**Participants/Methods:** 11 patients were implanted unilaterally in the posterior hypothalamus on the painful side. During the first part of the trial, each patient was randomized for 1 month to either an "on" or an "off" group. One month later, all stimulators were turned off for 1 week. At the end of that week, patients who were previously "on" were left "off," and those who were "off" during the first month were switched "on." One month later, all patients were switched "on" in the now open phase of the trial for 35 weeks. The primary end point was the number of attacks during the last week of each month of stimulation. The secondary end points were the amount of medication taken, intensity of pain, emotional impact, and quality of life.

**Results/Conclusions:** During the double-blind period of the trial, there was no difference between stimulated and unstimulated patients. During the following open phase of the trial, 6 patients had a >50% decrease in attack frequency, with 3 patients being pain free. None of these 6 responders agreed to be part of a new double-blind, randomized trial. Most complications were minor except for one infection, which necessitated re-implantation. A new double-blind trial is needed.

**Reviewer’s Comments:** Three factors might explain the absence of an effect of hypothalamic stimulation during the blind phase of the trial: (1) the sample size was too small; (2) the selected patients were not typical, having more frequent attacks than average; and (3) the period allowed for stimulation to reduce headaches was too short; it should have been at least 42 days. While the authors suggest that a new better-designed trial should be done, they acknowledge that subcutaneous stimulation of the occipital nerves might be as effective. The study of Burns and colleagues published in 2009 in the journal Neurology strongly supports this suggestion. (Reviewer-Luc Jasmin, MD).

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Keywords: Cluster Headaches, Deep Brain Stimulation, Hypothalamus, Neurostimulation, Multicenter, Crossover

Print Tag: Refer to original journal article
Background: Head and neck injuries occur commonly in skiers and snowboarders. Although studies have shown a protective effect of helmets with regard to head injury, an increased risk of neck injuries with helmet use, particularly in children, has been suggested.

Objective: To systematically review the effect of helmets on head and neck injuries among skiers and snowboarders.

Methods: The authors performed electronic searches of databases (MEDLINE, Academic Search Complete, SPORTDiscus, Embase, ERIC, PubMed, Cochrane Central Register of Controlled Trials, and SafetyLit) and manual searches of proceedings of the International Society of Skiing Safety conferences, as well as references of included studies. Full texts of studies were assessed if the abstract: (1) indicated cohort, case-control, or case-crossover design; (2) compared skiers or snowboarders with and without helmets; and (3) measured objectively quantified outcome. Methodological quality of studies was assessed by the Downs and Black checklist. Data extracted from selected studies utilized adjusted results over crude results with the effect of helmet use expressed as odds ratios (OR).

Results: 12 of 36 potential relevant studies were analyzed; 24 studies were excluded for inappropriate study design, failure to examine skiers or snowboarders with and without helmet use, or data not reported by outcome. Of the study participants, 9829 wore helmets and 36,735 did not. Pooled data showed that helmet use reduced the risk of head injury by 35% (OR, 0.66). For children <13 years old, the OR was 0.39; for beginning skiers and snowboarders, the OR was 0.69. Pooled data showed an OR of 0.89 for risk of neck injury with helmet use and an OR of 1.08 in children, indicative of no increase in risk. Design, quality, and fit of helmets were not reported in any study.

Conclusions: Helmets are effective in reducing the risk of head injury among skiers and snowboarders without increasing the risk of neck injury. Helmet use is encouraged.

Reviewer's Comments: Common sense tells us that helmet use will reduce head injury in skiers and snowboarders. Similar to the anti-motorcycle helmet lobby, naysayers retort that while helmets may be good for the head, they place users at increased risk for neck injury. This study refutes that claim, clearly showing that helmets reduce the risk of head injury and do not increase the risk of neck injury in a large number of participants. While the authors cited limitations (moderate quality of analyzed studies, variation in control groups, variation in head injury definition, and lack of helmet data) that are all true, these shortcomings do not detract from the key message of the paper. Neurosurgeons should foster head injury prevention. My children and I wear helmets when we ski. Others should do the same, without fear that prevention of head injury places them at increased risk for neck injury. (Reviewer-N. Scott Litofsky, MD).

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Keywords: Head Injury, Neck Injury, Helmet, Skiers, Snowboarders

Print Tag: Refer to original journal article
The CO₂ laser can create a deeper incision in brain tissue with a smaller area of adjacent thermal damage compared to a bipolar cauterization technique.

**Background:** CO₂ lasers were introduced into neurosurgery in the 1970s but fell out of favor due to the need for cumbersome microscope-mounted manipulators and the need to continuously re-align a visible aiming beam precisely with the invisible CO₂ laser wavelength. A photonic bandgap fiber has been developed to allow the surgeon to use this laser as a handheld tool.

**Objective:** To compare the degree of thermal injury incurred by adjacent brain tissue when using a flexible CO₂ laser fiber versus bipolar cauterization.

**Methods:** Laser or bipolar cauterization was delivered to the cortex of anesthetized adult swine. The CO₂ laser was delivered using the OmniGuide flexible CO₂ fiber at varying power settings and durations. The Malis Bipolar System was used to deliver bipolar cauterization. The laser was also applied at varying distances to the brain surface to assess the effect of beam divergence on laser tissue interaction. Histologic analysis assessed the degree of adjacent tissue damage. Zones of thermal damage were measured in depth and width.

**Results:** Higher laser power output increased the depth of thermal effect but minimally increased the width. In contrast, when the bipolar cautery energy setting was increased, it produced wider but not deeper zones. When the CO₂ laser was applied with a defocused beam by positioning further from the cortical surface, it created wider, shallower zones of desiccation and edema, similar to the lesions produced by the bipolar cauterization. When examined as a function of depth of coagulation, the total area of tissue affected by thermal energy was much higher when using bipolar cauterization compared to the CO₂ laser. In addition, higher power settings of the laser created deeper incisions without appreciably increasing the area of lateral thermal damage.

**Conclusions:** The flexible CO₂ fiber was easy to use and is able to both cut and coagulate small vessels, with minimal thermal effects on adjacent tissue. One limitation of the high water absorption of the CO₂ laser is that it requires a dry operative field and is unable to penetrate through cerebrospinal fluid. Vessels >1 mm in diameter require bipolar coagulation.

**Reviewer's Comments:** My personal clinical experience with the OmniGuide flexible CO₂ fiber supports the opinion of the authors. It is useful when excising firm tumors that respond poorly to Cavitron Ultrasonic Surgical Aspirator system. It is a non-contact tool, which can also be used to perform hearing preservation acoustic neuroma removal. The non-contact nature of the tool likely contributes to atraumatic extirpation. The advantages of the CO₂ laser when compared to other commercially available visible light lasers such as the Argon or KTP systems is that it is highly absorbed by water, so that the vaporization occurs at a very shallow depth of penetration. (Reviewer-Andrew J. Fishman, MD).