MAYO CLINIC

NeurosciencesUpdate

Neurologic Surgery and Clinical Neurology News

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INSIDE THIS ISSUE

Expertise in Skull Base Surgery

Skull base tumors pose significant challenges, due to their close proximity to important neurovascular structures and potential extension into neural canals or the cavernous sinus. Surgical resection can be associated with significant morbidity, including damage to the optic nerve and leakage of cerebral spinal fluid. Mayo Clinic in Rochester, Minn., has specialists with experience in a range of innovative surgical techniques for treatment of these complex cases.

"Everything we do centers around maximal safe resection of tumors, limiting comorbidity to patients and trying to get them back to the normal work or family life they previously had," says Jamie J. Van Gompel, M.D., a neurosurgeon at Mayo Clinic in Minnesota.

Mayo's experience with skull base lesions ranges from rare types — esthesioneuroblastomas, chordomas and chondrosarcomas—to the more common meningiomas, pituitary tumors, craniopharyngiomas and sinonasal malignancies. Mayo's expertise extends across several specialties. In addition to neurosurgeons, the skull base surgery team at Mayo is comprised of radiologists, otorhinolaryngologists, otologists, oncologists, radiation oncologists and plastic surgeons.

"There are a lot of advantages to having a facility with expertise in all fields," Dr. Van Gompel says. "We have developed a team with deep experience."

Neuroradiologists play a key role in diagnostic work and preoperative planning, as well as interpreting postoperative CT scans and MRI. During surgery Mayo neuroradiologists can use intraoperative MRI, which is particularly helpful in cases of more-complex lesions based in the central skull. The surgery is usually performed by both a neurosurgeon and an otorhinolaryngologist. "There are two expert sets of eyes, and often intraoperative discussion about what's best for the patient," Dr. Van Gompel says.

Mayo's practice focuses on using minimally invasive procedures whenever possible. In addition to an endoscopic endonasal approach, in which the tumor or lesion is removed through the nose (Figure), Mayo is also expanding its practice of endoscopic-assisted cranial surgery. That procedure requires a smaller craniotomy than cranial surgery performed with a microscope because while the microscope focuses light narrowly on a tumor, the endoscope emanates light outward. Endoscopic-assisted craniotomy can be used to reach very deep lesions with less morbidity.

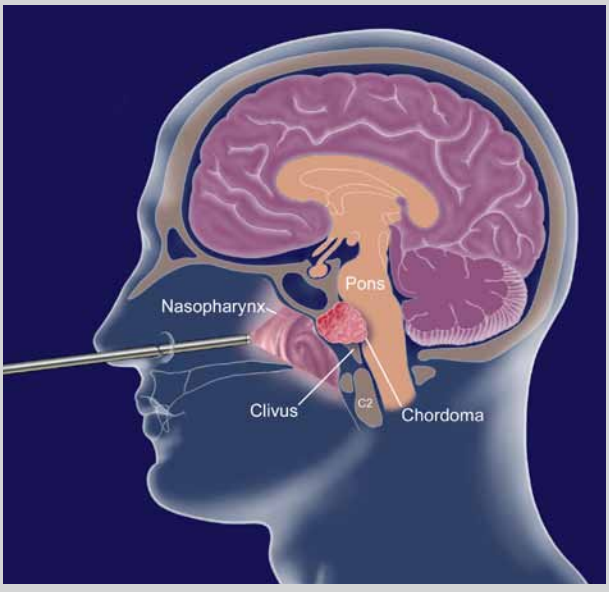

Figure. *An endoscopic endonasal approach can minimize damage to important neurovascular structures in surgery for skull base tumors such as chordoma.*

Jamie J. Van Gompel, M.D.

"With the microscope, craniotomies often are large because the opening determines the light at the resection," Dr. Van Gompel explains. "The endoscope brings visualization to the field where you're working, restricting the opening that you need. Therefore, patients should have less approach-related morbidity but the same tumor-related outcomes."

Proton beam therapy

To enhance treatment options for skull base tumors, Mayo is constructing a proton beam therapy facility in Rochester. When it opens, Mayo will be one of the few centers in the Midwest capable of offering both minimally invasive skull base surgery and proton beam therapy in a single center. That treatment regime is particularly appropriate for patients with chondrosarcoma or chordoma — tumors that tend to occur in older adolescents and young adults, for whom complex resection and large doses of radiation pose risks of long-term complications.

Approaches tailored to the patient

The range of experience and expertise at Mayo Clinic allows patients to receive care appropriate to their individual needs. "Endoscopic techniques are absolutely critical for treating chondrosarcomas and chordomas, in order to reach the portion of the skull base that can't be reached in any other way," Dr. Van Gompel says.

Yet open procedures remain necessary. Dr. Van Gompel is currently conducting research that indicates that in remotely located lesions, a traditional open approach can address one portion of the petrous apex. "But there is a smaller subsegment that you cannot see in the open approach," he notes. "So there actually are places and particular pathologies that need both open and endoscopic approaches."

Complex Spine Surgery in Florida

H. Gordon Deen Jr., M.D.

Mark A. Pichelmann, M.D.

Vertebral tumors and deformities can cause significant morbidity and pain. Surgery to treat patients with these conditions is inherently complex, posing risks to critical neurovascular structures. Mayo Clinic in Jacksonville, Fla., has a large team of neurosurgeons with experience in complex spine surgeries for tumors, deformities and other conditions.

"We treat a full range of spine problems including trauma, complex deformities, disk problems, and tumors of the spinal cord and spine, both primary and metastatic," says H. Gordon Deen Jr., M.D., a neurosurgeon at Mayo in Florida.

Among the spinal deformities treated is scoliosis — both idiopathic scoliosis in older adolescents and adult degenerative scoliosis. The latter may be seen in older adults who had minor scoliosis in adolescence and were treated with a brace.

"With the degenerative changes of aging on top of previous adolescent scoliosis, these older adults may again experience progression of spinal deformity and benefit from surgery," notes Mark A. Pichelmann, M.D., a neurosurgeon at Mayo in Florida.

Team approach

Mayo's commitment to team medicine is apparent in its approach to complex spine surgery. Two attending neurosurgeons often work together on highly complex cases. "There are a lot of decisions that must be made during the surgery. With two of us in the operating room, we can bounce ideas off each other," says Stephen Pirris, M.D., a neurosurgeon at Mayo in Florida.

The treatment team also includes anesthesiologists and nurses with experience in complex spine surgery. After surgery, patients work with an inpatient pain management service as well as physical, occupational and speech therapists to help with rehabilitation.

Another key component of Mayo's approach is intensive patient monitoring during surgery. Sensory and motor functioning of the spinal cord is monitored in real time, to minimize the patient's chances of developing new complications or neurological deficits.

Neurosurgeons at Mayo in Florida also have pioneered the use of 3-D image-guidance techniques, which allow spinal implants to be placed more safely. Enhanced image guidance facilitates placement of more robust implants with novel trajectories to better stabilize complex spinal deformities. These technologies, along with improvements in instrumentation and surgical techniques, enable Mayo neurosurgeons to treat more-complex cases than was previously possible.

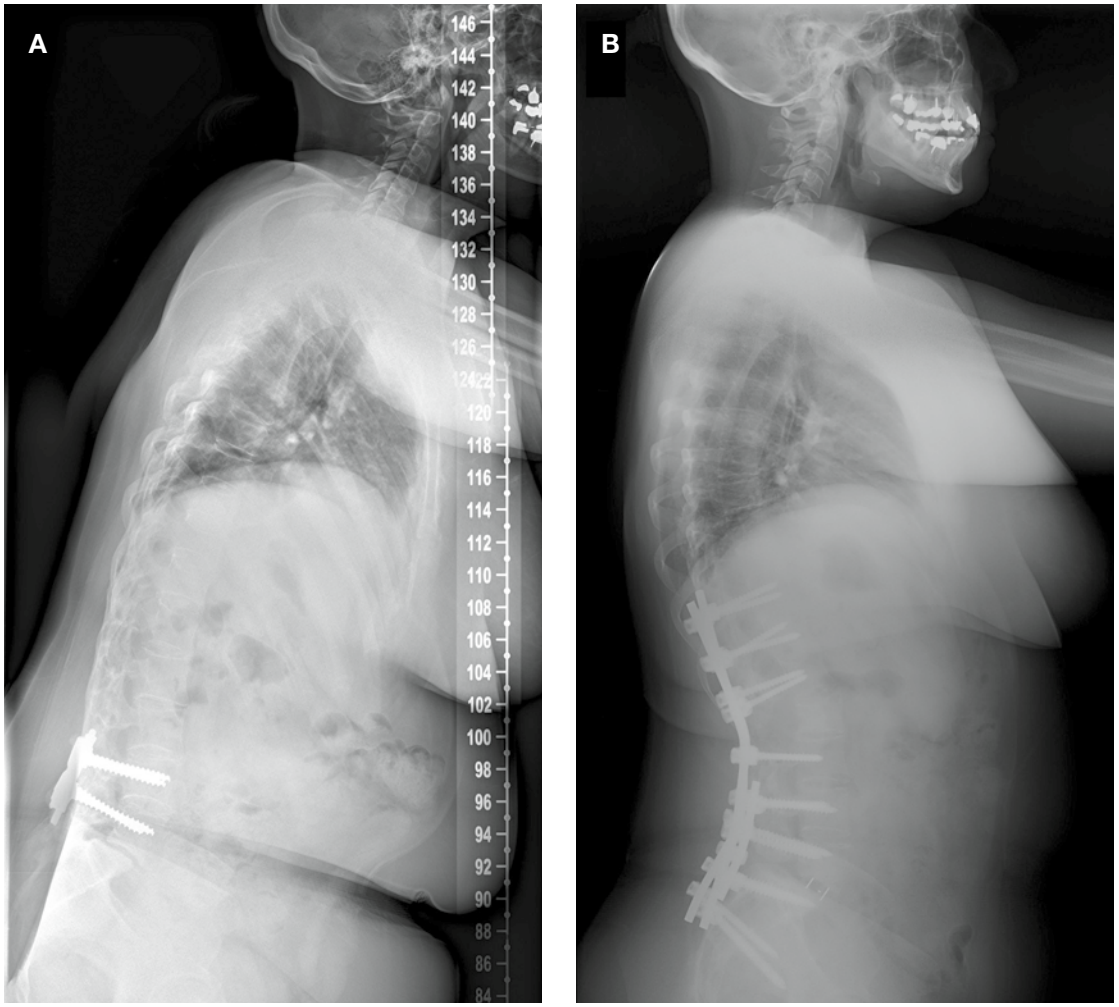

Figure. ***A****, Preoperative X-ray of a patient with kyphoscoliosis with sagittal imbalance and back pain.* ***B****, X-ray of the patient five months after complex spine surgery.*

Stephen Pirris, M.D.

"We are doing more osteotomies for complicated three-dimensional curvature," Dr. Pichelmann says. "We can essentially take the spine apart and put it back together with minimal risk to the spinal cord." Minimally invasive surgery and anterior-posterior surgery also are offered when appropriate.

Dr. Pirris notes that patients who undergo complex spine surgery must be able to tolerate a long and complicated procedure. Candidates for surgery are therefore selected according to their medical history and bone quality. The patients who tend to benefit most from spine surgery are those with sagittal imbalance, the most common determinant of back pain (Figure). "Chronic back pain that persists after surgery is frequently due to sagittal imbalance, and that is a potentially correctable problem," he says.

For more information

Nottmeier EW, et al. Placement of thoracic transvertebral pedicle screws using 3D image guidance. *Journal of Neurosurgery: Spine.* 2013;18:479.

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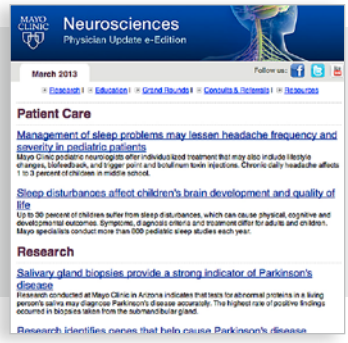

Expanding Epilepsy Monitoring in Arizona

Joseph I. Sirven, M.D

Treating patients with epilepsy requires careful characterization of seizure activity. All three Mayo Clinic campuses have an inpatient epilepsy monitoring unit where patients have continuous electroencephalography (EEG), measurement of oxygenation and cardiac status, and audiovisual recording of their activities.

In Arizona, Mayo is extending its epilepsy expertise across the state. Since 2011, Mayo Clinic specialists have collaborated with officials from Banner Health to create an epilepsy monitoring unit at Banner Good Samaritan Medical Center in downtown Phoenix. The six-bed unit is staffed by Mayo neurologists (Figure 1), with technicians and support teams from Banner Good Samaritan. Patients evaluated at the unit may receive treatment from Banner or be transferred to Mayo Clinic Hospital in Phoenix. Banner Good Samaritan draws patients from the Banner network throughout Arizona.

"This collaboration allows us to bring Mayo Clinic quality and safety of care to a large population of the state of Arizona," says Joseph I. Sirven, M.D., a neurologist at Mayo Clinic in Arizona. "This unit, which is Mayo branded but located within a Banner hospital, allows access to Mayo Clinic for patients who otherwise would not have it."

The unique clinical cooperation was launched in 2011. Neurologists from Mayo and Banner were already collaborating on research on dementia and Parkinson's disease. At the time Banner Good Samaritan lacked an epilepsy monitoring unit.

Figure 2. *Katherine H. Noe, M.D., Ph.D., a neurologist at Mayo in Arizona, leads a conference at Banner Good Samaritan that is beamed to Mayo Clinic Hospital in Phoenix.*

Figure 1. *Matthew T. Hoerth, M.D., a neurologist at Mayo Clinic in Arizona, in the Epilepsy Monitoring Unit at Banner Good Samaritan Medical Center in Phoenix.*

"Banner physicians wanted very much to have epilepsy monitoring capability to care for their large network of patients," Dr. Sirven says. "So they approached us with the idea of creating a Mayo epilepsy monitoring unit in their hospital."

As at other Mayo Clinic epilepsy monitoring units, an important component of care at Banner Good Samaritan is multidisciplinary case conferences (Figure 2). Those meetings bring together neurologists, medical technicians, nurses and psychologists to assess the safety and quality of the testing and treatment plan for each patient. A satellite connection allows epilepsy specialists at Mayo Clinic Hospital in Phoenix to participate in discussions with their Mayo colleagues at the Banner Good Samaritan unit.

According to a study published in the June 2009 issue of *Mayo Clinic Proceedings*, EEG monitoring is a safe and valuable tool for epilepsy classification, diagnosis of recurrent spells and evaluations for surgery in patients with intractable partial epilepsy. "At Mayo Clinic, we are committed to bringing the best safety and quality to care for patients with epilepsy," Dr. Sirven says. "Being part of the Banner Good Samaritan system extends Mayo's interactions with patients to a very large swathe of Arizona and allows us to set the tone for safety and quality of care for the state."

For more information

Noe KH, et al. Safety of long-term video-encephalographic monitoring for evaluation of epilepsy. *Mayo Clinic Proceedings*. 2009;84:495.

Stroke Telemedicine Launched in the Midwest

Mayo Clinic has been a leader in the field of stroke telemedicine, which uses audiovisual technology to connect patients in rural areas with stroke specialists at hub hospitals. Starting at Mayo Clinic in Phoenix, Ariz., stroke telemedicine subsequently expanded to Mayo's campus in Jacksonville, Fla. Now, Mayo Clinic in Rochester, Minn., is a stroke telemedicine hub serving 18 hospitals in the Mayo Clinic Health System in Minnesota and Wisconsin (Figure 1).

"We're expanding the Mayo Clinic model of care for stroke telemedicine to the Upper Midwest. The goal is to bring Mayo Clinic stroke expertise to each of the sites in our health system, through collaboration with physicians and other providers at those sites, and then expand later this year to non-Mayo sites as well," says Robert D. Brown Jr., M.D., a neurologist at Mayo in Minnesota.

Like the Mayo campuses in Arizona and Florida, the Minnesota site has a stroke subspecialty neurologist available around the clock for consultation with emergency room providers in network hospitals. The stroke specialist conducts patient evaluations remotely, using technology brought to the patient's bedside (Figure 2). CT scans can be uploaded and immediately reviewed by the stroke specialist in Rochester, and therapeutic options discussed with the treatment team at the network hospital.

"The system provides a high-quality audiovisual connection, with the ability to focus the camera on the patient, zoom in and out, tilt up and down, and pan from side to side. We can both review the imaging and share the image back again with the team at the bedside, pointing out any key findings for the patient, their family or the providers," Dr. Brown says.

Stroke telemedicine increases the likelihood that patients who need clot-dissolving or other advanced therapies receive them quickly,

Robert D. Brown Jr., M.D.

Figure 1. *The stroke telemedicine network with its hub at Mayo Clinic in Rochester, Minn. Stars indicate communities with hospitals in the Mayo Clinic Health System served by the telemedicine network. Mayo Clinic Hospital in Phoenix, Ariz., and Mayo Clinic Hospital in Jacksonville, Fla., also are stroke telemedicine hubs serving hospitals in their respective regions and beyond.*

Bart M. Demaerschalk, M.D.

thereby lessening the risk of significant deficit after stroke. "If intra-arterial therapies are required, patients can be immediately airlifted to Rochester, where emergency diagnostic cerebral angiogram and endovascular therapy capabilities are available 24/7 for advanced intervention," Dr. Brown notes. Patients may also be transferred to the Mayo system's hospitals in La Crosse, or Eau Claire, Wis.; or Mankato, Minn.

Expansion beyond Mayo Clinic Health System

The goal over time is to extend stroke telemedicine to hospitals outside the Mayo Clinic Health System. That effort will draw on Mayo's experience in Arizona and Florida, where network hospitals typically aren't part of the Mayo Clinic Health System, but some are affiliated in other ways, such as through the Mayo Clinic Care Network.

"We're basing our model on the very advanced and mature program that exists at Mayo Clinic in Arizona and in Florida. Our colleagues there are assisting us because this is an enterprisewide effort to cover stroke telemedicine very broadly," Dr. Brown says. Telemedicine at Mayo in Minnesota will also be extended eventually to other neurological conditions, such as epilepsy, neurological emergencies other than stroke, and sports concussion, as it has been at Mayo in Arizona.

"Connecting with patients and referring physicians is critical to Mayo Clinic's strategic direction as we deliver knowledge, expand reach and transform health care," says Bart M. Demaerschalk, M.D., a neurologist at Mayo in Arizona and the founder of the Mayo Clinic telestroke network there. "Telestroke is the most mature of any telemedicine service line in the clinical neurologic sciences and is supported by a strong body of evidence demonstrating its reliability, validity, safety, efficacy, and clinical and cost effectiveness compared with, face-to-face stroke care. While a real stroke team at the bedside is desirable, a virtual stroke team can approximate the real thing and is quickly becoming the standard of care in every acute care environment lacking emergency stroke services."

Figure 2. *The Clinical Assistant telemedicine cart. Photo courtesy of Avizia Inc.*

Research Highlights in Neurology and Neurologic Surgery

Neurosciences Research

Plasma Ceramide and Glucosylceramide Metabolism Is Altered in Sporadic PD

Mutations in the gene coding for glucocerebrosidase (GBA) — which metabolizes glucosylceramide, a monohexosylceramide, into glucose and ceramide — is the most common genetic risk factor for sporadic Parkinson's disease (PD). GBA mutation carriers are more likely to have an earlier age of onset and to develop cognitive impairment and dementia. A study by researchers at Mayo Clinic in Rochester, Minn., and colleagues suggests that plasma ceramide and monohexosylceramide metabolism is altered in non-GBA mutation carriers with PD, and that higher levels are associated with worse cognition. The study involved 57 patients: 26 cognitively normal PD patients, 26 PD patients with cognitive impairment or dementia, and a control group of five cognitively normal patients without PD. Levels of all lipid species were higher in the PD patients versus non-PD controls. Among PD patients, levels of ceramide and monohexosylceramide were higher in those with cognitive impairment versus those without. (Mielke MM, et al. Plasma ceramide and glucosylceramide metabolism is altered in sporadic Parkinson's disease and associated with cognitive impairment: A pilot study. *PLOS ONE*. In press.)

MRI and MRS as Predictors of MCI

Patients with mild cognitive impairment (MCI) who demonstrate hippocampal atrophy on MRI and metabolite abnormalities on magnetic resonance spectroscopy (MRS) have an increased risk of incident dementia compared with patients with only one of those abnormalities. Researchers at Mayo Clinic in Rochester, Minn., have shown that quantitative MRI and MRS markers can predict progression to MCI and cognitive decline in cognitively normal older adults. The research involved 1,156 cognitively normal older adults from Olmsted County, Minn., who participated in the Mayo Clinic Study of Aging MRI/MRS study from August 2005 to December 2010, and had at least one clinical follow-up evaluation until October 2012. Participants in the prospective, population-based study underwent neuropsychological testing as well as MRI and MRS to assess hippocampal volume, white matter hyperintensities, brain infarcts and metabolite abnormalities. After a median follow-up of 2.8 years, 214 participants had progressed to MCI or dementia. In univariable modeling, hippocampal volume, white matter hyperintensity volume and the metabolite N-acetylaspartate/myo-inositol were significant predictors of MCI in the study cohort. The results suggest that MRS may contribute to the assessment of preclinical dementia pathologies by capturing neurodegenerative changes that are not detected by hippocampal volumetry. (Kantarci K, et al. MRI and MRS predictors of mild cognitive impairment in a population-based sample. *Neurology*. 2013;81:126.)

Updated Model of Alzheimer's Progression

An updated hypothetical model of the sequence of change in Alzheimer's disease biomarkers was presented at the annual Alzheimer's Association International Conference by Clifford R. Jack Jr., M.D., a neuroradiologist at Mayo Clinic in Rochester, Minn., and colleagues. Based on research evidence that has accumulated since the previous model was published in 2010, the updated model shows more overlap between changes in biomarkers, describes changes in biomarkers in relation to time not severity of symptoms, expresses cognitive outcome as a range of possible values and orders the biomarkers somewhat differently. The updated biomarker ordering is:

- Change in Aβ42 in cerebrospinal fluid (CSF)
- Images of amyloid buildup assessed by a PET scan
- Changes in tau measured in CSF
- Brain volume measured by fludeoxyglucose (FDG), PET and MR imaging — which are drawn coincidentally to indicate that they are the last biomarkers to become abnormal, but track most closely with progressive cognitive impairment.

Clinical Trial of Rifampicin for Treating MSA

The hallmark of multiple system atrophy (MSA) is glial cytoplasmic inclusions consisting of aggregated a-synuclein. In a transgenic mouse model of MSA, rifampicin inhibits formation and disaggregates a-synuclein fibrils and improves both behavioral and neuropathological changes. Researchers at Mayo Clinic in Rochester, Minn., and colleagues conducted a randomized, double-blind, placebo-controlled 12-month clinical trial of the safety and efficacy of rifampicin in 100 patients with possible or probable MSA. Although the results indicated no beneficial effects of rifampicin in slowing or halting the progression of MSA, the researchers established an infrastructure to carry out further studies and demonstrated that it is feasible to carry out phase III clinical trials of MSA in the U.S.

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Year-round

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Jan. 1-Dec. 31, 2013
Mayo Clinic, Stabile Building, Rochester, Minn.

Expanded Autonomic Training
Jan. 7-Dec. 31, 2013
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2014 courses

March

Mayo Clinic EMG, EEG and Neurophysiology in Clinical Practice
March 2-7, 2014
Mayo Clinic, Education Center, Phoenix

Tackling Problematic Chronic Rhinosinusitis: A Conclave of Global Experts
March 27-29, 2014
Mayo Clinic, Education Center, Phoenix

April

Southwest Laryngology and Voice Rehabilitation Conference
April 4-5, 2014
Mayo Clinic, Education Center, Phoenix

May

Neurorehabilitation Summit
May 19-20, 2014
DoubleTree, Rochester, Minn.

September

Neuro-Ophthalmology in Clinical Practice
Sept. 19-21, 2014
Orlando, Fla.

September (continued)

Stroke and Cerebrovascular Reviews
Sept. 25-28, 2014
Amelia Island, Fla.

October

Practical Clinical Neurology for the Primary Care Physician
Oct. 20-23, 2014
Orlando, Fla.

November

Parkinson's Disease & Other Movement Disorders for the Practitioner — 2014
Nov. 7-8, 2014
Mayo Clinic, Education Center, Phoenix

Neuroradiology: Practice to Innovation
Nov. 10-14, 2014
The Ritz-Carlton, Dove Mountain, Marana, Ariz.

Information and registration

Mayo Clinic in Minnesota:
Phone: 800-323-2688 (toll-free) or 507-284-2509
Email: *cme@mayo.edu*

Mayo Clinic in Florida:
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Email: *cme-jax@mayo.edu*

Mayo Clinic in Arizona:
Phone: 480-301-4580
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Website: *www.Mayo.edu/cme/neurology-and-neurologic-surgery*

Expedited Patient Referrals to Mayo Clinic Departments of Neurology and Neurologic Surgery

While Mayo Clinic welcomes appointment requests for all neurologic and neurosurgical conditions, patients with the following conditions are offered expedited appointments:

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2. Cerebral or spinal arteriovenous malformations
3. Brain, spinal cord or peripheral nerve tumors
4. Epilepsy with indications for surgery
5. Carotid disease

MAYO CLINIC
mayoclinic.org

4500 San Pablo Road
Jacksonville, FL 32224

200 First Street SW
Rochester, MN 55905

13400 East Shea Boulevard
Scottsdale, AZ 85259

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