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The Evolution of Endovascular Therapy for Neurosurgical Disease

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The exponential evolution of endovascular neurosurgery over the past few decades has redefined the treatment strategies for cerebrovascular diseases. Entering the new millennium, one must have the mindset to embrace and nurture the progress and technologic advances. A review of the critical historical steps and bold pioneering attempts is appropriate to gain a sense of the future and discover the renewed pertinence of past ideas.

Preparation of the Interventional Suite for Treatment of Neurovascular Diseases and Emergencies

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Christopher J. Koebe, Charles A. Guidot, Brett Campanella, Jeffrey Balzer, and Elad I. Levy

The expansion of endovascular technology has increased the scope of procedures that may be performed in the neurointerventional suite. Given the broad range of neurovascular disorders treated in the neurointerventional suite, the design of a new suite requires attention to efficient space management and to flexibility so as to perform open procedures in a sterile environment. The neurointerventional suite of tomorrow should be designed to accommodate the needs of the many team members involved, including anesthesiology, neurophysiology, and nursing staff as well as the interventionist. The neurointerventionist must develop a surgical plan before entering the suite and coordinate the efforts of all team members during an endovascular procedure.

Indications for Catheter-Based Angiography of the Cerebrovasculature

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Brian Jankowitz, Elad I. Levy, L. Nelson Hopkins, and Lee R. Guterman

Despite recent advances in ultrasonography, CT, and MRI technologies, there still remains a need for digital subtraction angiography as a first- or second-line modality for the radiographic diagnosis of cerebrovascular disorders. The conditions and disease processes for which diagnostic cerebral angiography remains superior to less invasive or noninvasive techniques are discussed in this article.

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The use of occlusion of intracranial vessels as a strategy for the treatment of various intracranial conditions is not a new phenomenon. The use of balloon test occlusion (BTO) with various adjunctive tests can, however, offer a safe provocative test of the patient's cerebrovascular reserve and is a new treatment paradigm. The use of BTO can guide a selective revascularization strategy when cervical or intracranial arterial sacrifice is considered.	
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<p>Intracranial atherosclerosis is the third leading cause of ischemic stroke, and patients with known intracranial stenoses seem to be at high risk for the development of a stroke. Despite the high prevalence of this disease process, intracranial atherosclerosis remains tremendously difficult to treat, and failure rates associated with the best medical therapy are unacceptably high. An emerging alternative therapy for patients with intracranial atherosclerosis is intracranial angioplasty with or without stenting. Endovascular techniques have already been shown to be feasible for patients with medically refractory disease. The authors demonstrate the risks and benefits of endovascular therapy for intracranial stenosis as well as the newer directions of the field, including drug-eluting stents and staged stenting.</p>	
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<p>The endovascular treatment of cerebral arteriovenous malformations (AVMs) has advanced greatly in the four decades since Luessenhop and Spence first described the use of silastic spheres to embolize an AVM. The innovations have been in the agents used to embolize as well as in the devices used to deliver the agent to the AVM. Endovascular therapies have helped to decrease operative morbidity by making it easier for the surgeon to resect the AVM and, in some cases, by eliminating the need for surgery</p>	

altogether. The benefit of size reduction not only benefits the surgical treatment of AVMs but improves the efficacy of stereotactic radiosurgery. The authors expect that the future will bring continued advances; with such advances, the morbidity associated with AVM treatment should drop even lower.

Indications for Surgical Treatment of Arteriovenous Malformations

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Peter Nakaji and Robert F. Spetzler

The complexity of arteriovenous malformations (AVMs) of the brain varies widely. In general, Spetzler-Martin grades I through III AVMs or those with certain high-risk features should be treated; grades IV through V AVMs often are best managed conservatively. The exact treatment strategy for any individual lesion should be formulated by a multidisciplinary team that includes experts in microsurgery, endovascular surgery, and radiosurgery. Multimodal treatment is common. Microsurgical removal remains the definitive form of treatment.

Endovascular Treatment of Cerebral Arteriovenous Malformations: Indications, Techniques, Outcome, and Complications

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Kevin M. Cockroft, Sung-Kyun Hwang, and Robert H. Rosenwasser

This article discusses the role of endovascular strategies in the treatment of cerebral (pial) arteriovenous malformations (AVMs). The indications, techniques, complications, and clinical results are outlined. Embolization is indicated as an adjunctive therapy to reduce AVM volume before surgical resection or stereotactic radiosurgery. In carefully selected patients, embolization alone may also be curative. Endovascular methods have evolved from nonselective techniques using particle emboli to carefully orchestrated superselective procedures using flow-directed microcatheters and liquid embolic cyanoacrylate glue derivatives. Despite potential ischemic and hemorrhagic complications, endovascular embolization has proven to be clinically safe, with acceptable rates of periprocedural morbidity and mortality. In the current era, the treatment of cerebral AVMs, particularly complex lesions, seems to be best performed at centers where the major treatment modalities of endovascular embolization, microsurgery, and stereotactic radiosurgery are all readily available and a tailored multidisciplinary approach is provided to each patient.

Treatment of Dural Arteriovenous Malformations and Fistulae

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Henry H. Woo, Thomas J. Masaryk, and Peter A. Rasmussen

Dural arteriovenous malformations or fistulae (DAVFs) are pathologic arteriovenous connections located within the leaflets of the dura mater. Their clinical presentation is dependent on their location and pattern of venous drainage. The initial presentation can range from asymptomatic to intracranial hemorrhage. Their potential for a malignant clinical course is determined by the presence of leptomeningeal venous drainage, and its presence mandates an angiographic cure. Before any type of treatment, a careful analysis of the angiogarchitecture, especially on the venous side, is necessary. Endovascular treatment is the first-line therapy for most DAVFs, but even if angiographic obliteration cannot be obtained, it serves as an adjunct for surgery. A multidisciplinary approach is essential to engender the safest and most effective outcome.

Endovascular Techniques for Vascular Malformations of the Spinal Axis

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Cameron G. McDougall, Vivek R. Deshmukh, David J. Fiorella,
Felipe C. Albuquerque, and Robert F. Spetzler

Improvements in our ability to care for patients with neurovascular conditions have been facilitated by advances in imaging, embolic materials, and delivery systems and

fostered by growth in understanding of the clinical features of the causative lesions. This article describes the role of endovascular techniques in the management of spinal axial vascular lesions.

Preoperative Embolization of Central Nervous System Tumors

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Vivek R. Deshmukh, David J. Fiorella, Cameron G. McDougall,
Robert F. Spetzler, and Felipe C. Albuquerque

Surgical excision of hypervascular tumors of the central nervous system (CNS) can be daunting. Preoperative embolization can significantly mitigate resection with minimal associated morbidity and mortality. This article describes embolization techniques, reviews the key features and natural history of hypervascular CNS tumors, and offers caveats to minimize complications.

Endovascular Treatment of Acute Stroke

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Mark R. Harrigan and Lee R. Guterman

Timely endovascular treatment of acute ischemic stroke can lead to improvements in recanalization rates and clinical outcomes for selected patients. Built on early success with intravenous thrombolysis and capitalizing on rapidly evolving interventional techniques and technology, intra-arterial thrombolysis is emerging as an effective option for carefully selected patients. This article reviews the published experience with intra-arterial thrombolysis and outlines the indications, techniques, and devices needed for effective endovascular management of patients with acute ischemic stroke.

Training Standards in Endovascular Neurosurgery

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Jay U. Howington, L. Nelson Hopkins, David G. Piepgras, and
Robert E. Harbaugh

Interventional neuroradiology began as a subspecialty in which the practitioners were radiologists. Neurosurgeons became involved in endovascular techniques as a natural extension of their skills and experience in the management of patients with structural central nervous system diseases, especially cerebrovascular conditions. Currently, the percentage of trainees who are neurosurgeons is on the rise, whereas the number of radiologists is on the decline. Other specialists, including neurologists, vascular surgeons, and cardiologists, are now entering the field of neurointerventional procedures, particularly as applied to extracranial vascular disease. The purpose of this article is to stress the benefits of the collaborative effort among specialties, to review the current neurosurgical credentialing guidelines, and to consider the options for accelerated training in the rapidly evolving field of endovascular neurosurgery.

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