The year 2002 in therapeutic neuroradiology has been dominated by the publication of the International Subarachnoid Aneurysm Trial (ISAT), which has already generated considerable debate among those who treat cerebral aneurysms. Although less dramatic, advances have also occurred in the areas of extracranial and intracranial angioplasty/stenting, endovascular stroke therapy, and cerebral arteriovenous malformation (AVM) embolization.

Cerebral Aneurysms

Guaranteed to be controversial, the interim results of ISAT\(^1\) showed a 22.6% relative and a 6% absolute risk reduction of dependency or death for coiling relative to surgery in the treatment of cerebral aneurysms, triggering a premature halt to the trial. The results suggest that in patients with small, ruptured anterior circulation aneurysms who are good neurologic grade and are candidates for either endovascular coiling or surgery, the incidence of an outcome free of disability at 1 year is higher with coils. Critics have vocally pointed out the large number of patients who were eligible for the study but were not randomized (7416), the initially limited follow-up, and the small number of participating North American centers, reflecting a known practice bias. The continuing analyses of this data, particularly long-term recanalization rates with coils, promise to be very instructive. Nevertheless, the future of aneurysm surgery may ultimately belong to those who can coil or clip.

There have been many modifications and advances in coil technology to address the problems of wide-necked aneurysms and recanalization. Coils have been used to deliver beta radiation,\(^2\) bioabsorbable polymers,\(^3\) and gene-delivery vectors\(^4\) to promote thrombosis and cellular response inside aneurysms. Neck bridging devices\(^5\) and balloon and stent-assisted techniques\(^6,7\) using coils and solid polymers such as Onyx have all been used to successfully manage wide-necked and surgically inaccessible lesions. Three-dimensional angiography is becoming the gold standard for decision making regarding optimal aneurysm treatment.\(^8\)

Angioplasty/Stenting for Cerebrovascular Disease

Extracranial Carotid Angioplasty/Stenting

The observational evidence is rapidly growing to support the widespread use of carotid angioplasty/stenting (CAS), even in ambulatory patients.\(^9\) Cerebral protection devices are becoming standard (yet expensive) additions to the procedure.\(^10,11\) Nets, filters, and balloon aspiration systems can drop the complication rates to as low as 0.3% in experienced hands,\(^10\) although they all involve passing more instrumentation across friable plaque. Following the technological lead of cardiology, drug-eluting and bioactive stents for the prevention of restenosis\(^12\) will likely soon find neurovascular applications.

There remains continuing debate, however, over who should undergo CAS.\(^13\) There is still no scientific evidence to support the use of CAS over carotid endarterectomy (CEA) in appropriate patients or the use of CAS in asymptomatic patients.\(^14\) The only generally accepted indications for CAS remain patients with medical (usually cardiac) contraindications to CEA, postirradiation carotid stenosis, restenosis of a prior CEA, high cervical lesions, or contralateral occlusions. Scientific evidence from a randomized clinical trial comparing CAS to CEA, such as the Carotid Revascularization Endarterectomy versus Stent Trial (CREST), is still at least several years away.

Intracranial Angioplasty/Stenting

There have been many case reports of successful angioplasty/stenting of intracranial vessels, with objective evidence of improved cerebral blood flow using perfusion imaging techniques. The largest case series, however, demonstrate that this remains a relatively high-risk procedure. In the vertebrobasilar circulation, the risk of stroke and death can approach 28%.\(^15\) The use of more flexible cardiology balloons and stents can achieve impressive morphological results in both the anterior and posterior circulation with complication rates as low as 12%.\(^16\) More experience and comparison with current best medical management is still required before this procedure becomes widespread.

Thrombolysis

Intraarterial (IA) delivery of thrombolytic agents is now commonly being combined with preliminary or concurrent intravenous (IV) administration of agents such as the platelet glycoprotein receptor IIb/IIIa antagonist abciximab. Improved recanalization rates and clinical response in small numbers of patients have been demonstrated in the anterior and posterior circulation.\(^17,18\) The combined IV/IA approach may provide better results in patients with distal internal carotid artery occlusions, a group relatively unresponsive to IA therapy alone.\(^19\) Routine use of perfusion-weighted MRI to select patients for IA therapy after IV t-PA can produce better clinical results than the EMS Bridging Trial in acute stroke.\(^20,21\) Vigorous mechanical clot
disruption with guidewires and snares combined with low-dose reteplase can restore flow in a large proportion of acute stroke patients, with a decreased incidence of intracerebral hemorrhage compared with high-dose IA thrombolysis alone.22

AVMs

The fundamental principles of AVM embolization have not changed, with the primary objective being to reduce the nidus size before surgery or radiation therapy. A recent review of a single-center series of 545 procedures confirmed that this could be done with a low risk of permanent, disabling, treatment-related neurologic deficit (2%).23 A small proportion may be cured by endovascular therapy, and the development of alternative agents to the notoriously temperamental n-butylcyanoacrylate may facilitate this goal. Derivatives of ethylene vinyl alcohol polymer such as Onyx are now being used to occlude AVMs in a more controlled fashion because of the nonadhesive properties of these compounds.24-25 Initial concerns regarding the toxicity of the solvent dimethyl sulfoxide have been successfully addressed. Whether use of these compounds will translate into improved cure rates with fewer complications awaits additional experience and long-term follow-up.

Summary

It is becoming clear that the complete management of cerebrovascular disease requires practitioners who possess endovascular skills. Ever increasing numbers of vascular neurosurgeons are seeking interventional training, and the growing field of interventional stroke neurology is attracting many young neurologists. The American Society of Interventional and Therapeutic Neuroradiology has established guidelines to ensure that these candidates receive a good grounding in the underlying radiological sciences.26 The discipline of interventional neuroradiology may become the model of a fruitful collaboration between multiple specialties working together for maximum patient benefit.

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