Although the traditional use of intravenous (IV) thrombolytics is restricted to within 3 hours of stroke onset, the use of intra-arterial (IA) therapy is proving to be more flexible, with the ultimate time window yet to be determined. Anecdotal evidence suggests that thrombectomy may be effective beyond the 6-hour window in properly selected patients. Clinical success and the incidence of complications may be more dependent on the results of perfusion-imaging and the presence of large-vessel occlusion and less on an arbitrary time window. Multimodality strategies are becoming more popular. A combination of mechanical clot retrieval and adjunctive thrombolytic therapies in 111 patients participating in the Multi MERCI trial resulted in successful recanalization in 69% of vessels versus 54% with the retriever alone. The preliminary results of the IMS II trial indicate that the MicroLysus ultrasound device (EKOS Corp) may improve recanalization rates compared with standard microcathether techniques. Multimodal therapy combining IV or IA abciximab and intracranial angioplasty has been reported to achieve high recanalization rates, and preliminary experience with intracranial stenting in acute stroke suggests that this may be an attractive adjunct to IA thrombolytics. A retrospective review of 168 patients treated with a combination of IA thrombolytics and mechanical interventions reported recanalization in 63% and improvement in NIHSS of at least 4 points in 21% of patients at 24-hour follow-up, with the highest recanalization rates seen in patients in whom 3 or more IA modalities were used. Not surprisingly, however, the rate of symptomatic intracranial hemorrhage was 14%. The high morbidity and mortality rates that continue to complicate IA therapies may be attributable to the inherent selection bias toward large-vessel occlusions and the resultant initial severity of these strokes.

Angioplasty and Stenting for Atherosclerosis of Extracranial and Intracranial Arteries

Over the past year, the results of 4 large extracranial carotid angioplasty (CAS) investigations have been reported. The industry supported ARChER and BEACH registries of non-randomized, symptomatic and asymptomatic patients at high risk for carotid endarterectomy found 30-day stroke or death rates of 6.9% and 5.8% respectively, and ARChER reported a 1 year composite outcome including myocardial infarction of 9.6%. The European EVA-3S and SPACE investigators reported on symptomatic patients randomized to receive either CAS or carotid endarterectomy. EVA-3S was stopped prematurely when the 30-day rate of stroke or death was significantly higher in the CAS group (9.6%) than in the carotid endarterectomy group (3.9%). In the SPACE trial, the 30-day stroke or death rate was 6.8% after CAS, and 6.3% after carotid endarterectomy, with slightly higher complication rates when embolic protection devices were used during CAS. Cerebrovascular embolization and hemodynamic changes after CAS continue to be investigated. Changes on diffusion-weighted MR images are seen less often with the use of embolic protection devices, but can still be seen in up to 42% of patients in the distribution of the stented artery. CT perfusion, MR volume flow quantification and transcranial Doppler ultrasound methods have all shown improvement in cerebral blood flow parameters post-CAS, but there are as yet no long-term results or direct comparisons with bare metal stents. No randomized controlled trials have evaluated angioplasty and/or stenting for intracranial arterial stenosis. A recent review of the 79 published case series found an overall perioperative stroke rate of 7.9% and stroke or death rate of 9.5%. Perforator strokes after intracranial angioplasty and stenting were found in 3% of patients, and those with pre-existing strokes adjacent to the stenotic segments were at greatest risk of symptom exacerbation. A new, self-expanding intracranial stent for atherosclerosis treatment (Wingspan, Boston Scientific) has shown initial promise in small numbers of patients.

Aneurysms

The endovascular treatment of cerebral aneurysms continues to evolve, as current technology is used in innovative ways to address complex lesions. Flexible stents are being combined with balloons and coils to treat “ultra-wide-necked” aneurysms, and a stent alone approach has been useful for treating pseudoaneurysms, which previously required proxi-
nal occlusion. A new, closed-cell retractable stent has recently shown promise for difficult lesions. In-stent stenosis, however, may occur in up to 6% of patients, and can occur as early as 2.5 months after implantation. Critical stenosis, however, may occur in up to 6% of patients, and can occur up to 2 years. The incidence of thromboembolic complications is still significant, and they are most prevalent when balloon-remodeling techniques are used for wide-necked aneurysms. Various regimens using aspirin and tirofiban have been proposed to limit and treat these events. The superiority of bioactive over bare platinum coils for promotion of aneurysm healing continues to be evaluated, but has been questioned by some investigators. As modern, non-invasive imaging is used to detect and follow cerebral aneurysms more frequently, the management of unruptured aneurysms becomes more controversial. Ischemic lesions on diffusion-weighted MRI can be detected in up to 42% of patients undergoing coil of unruptured aneurysms, and there has been support for a randomized controlled trial of observation versus best treatment for these lesions.

Vasospasm

The interventional options for cerebral vasospasm remain limited to intra-arterial administration of drugs and balloons. Papaverine is becoming less popular because of renewed concerns over raised intracranial pressure, whereas there is little evidence to differentiate the efficacies of verapamil, nimodipine, nicardipine, milrinone, fasudil and colforsin darpate. Balloon angioplasty remains the mainstay of treatment, with over 90% success rates and complication rates under 5%. There is still a need for the development of more flexible, softer, dedicated balloons, particularly for disease involving the anterior cerebral artery. Perfusion CT shows promise for the early diagnosis of vasospasm and may obviate the need for conventional digital subtraction angiography before intervention.

Arteriovenous Malformations

The endovascular therapy of brain arteriovenous malformations (AVMs), both ruptured and unruptured, continues to undergo considerable evidence-based scrutiny. There is no evidence from randomized trials comparing the results of different interventions alone or in combination, including neurosurgical resection, stereotactic radiation and embolization. One such study, ARUBA (A Randomized Trial of Unruptured Brain AVMs), is in the planning stages and will test the theory that the 5-year functional outcome after any type of intervention for unruptured AVMs is no better than observation. Between $150 to $300 million is spent annually in the United States treating unruptured AVMs, yet the overall risk of hemorrhage and associated morbidity and mortality may be considerably lower than originally believed (<2%/year). The risks of new deficits from embolization alone may be up to 22% and when combined with surgical resection, up to 50%. No new embolic agents have become available in the past year, with n-butyl cyanoacrylate (NBCA), Onyx and polyvinyl alcohol particles still used most often.

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