Short-Term Arteriographic and Clinical Outcome after Cerebral Angioplasty and Stenting for Intracranial Vertebralbasilar and Carotid Atherosclerotic Occlusive Disease

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BACKGROUND AND PURPOSE: The safe performance of percutaneous transluminal cerebral angioplasty for intracranial atherosclerotic lesions requires that the risk of complications, such as acute occlusion or symptomatic dissection, and restenosis be reduced. Our purpose was to assess the effectiveness, safety, and short-term arteriographic and clinical outcome of cerebral angioplasty and stenting (CAS) for intracranial vertebrobasilar and distal internal carotid atherosclerotic occlusive lesions.

METHODS: Between March 1998 and November 1998, 10 patients with 12 intracranial atherosclerotic lesions of the vertebrobasilar artery and the distal internal carotid artery underwent treatment with flexible balloon-expandable coronary stents.

RESULTS: Although in two of the 10 patients CAS was not successful because of the inability to access the site of arterial stenosis, 10 lesions in eight patients were successfully dilated with stents. No complications occurred during or after the procedure and no neurologic ischemic events or restenoses occurred during the follow-up period.

CONCLUSION: CAS appears to be a safe and effective means for treating intracranial atherosclerotic occlusive disease, yielding a favorable arteriographic and clinical outcome.

Percutaneous transluminal cerebral balloon angioplasty (PTCBA) has been used to treat stenosis of the intracranial artery since 1980, when Sundt et al (1) performed the first intracranial angioplasty in the basilar artery (BA). Although some investigators have reported good results after intracranial PTCBA (2–4), others have described high rates of morbidity and mortality (5, 6). The lack of devices to resolve untoward complications associated with intracranial PTCBA has undoubtedly contributed to these statistics; indeed, the development of several types of balloon-expandable metallic stents for treating the coronary artery has reduced the occurrence of procedure-related morbidity (7, 8). Long-term patency after coronary stenting has also been reported (9). The purpose of this study was to assess the effectiveness, safety, and short-term arteriographic and clinical outcome of treatment with flexible coronary stents for intracranial atherosclerotic occlusive lesions.

Methods

A total of 93 consecutive percutaneous transluminal cerebral angioplasties of the intracranial artery were performed in our institution between January 1992 and November 1998. Among 19 consecutive cerebral angioplasties performed in 17 patients between March 1998 and November 1998, 12 intracranial atherosclerotic lesions of the vertebrobasilar artery and the distal internal carotid artery (ICA) in 10 patients were treated with cerebral angioplasty and stenting (CAS), whereas seven lesions of the middle cerebral artery (MCA) in seven patients were treated with balloon angioplasty alone. The mean age of the 10 patients (nine men and one woman) was 68 ± 9 years. Lesions involved the distal ICA in four patients, the intracranial vertebral artery (IVA) in five patients, and the BA in three patients (Table). Nine of the 10 patients were symptomatic and one was asymptomatic.

Inclusion criteria for the CAS study were 1) significant stenosis (60% or more) of one of the following major intracranial arteries: the distal ICA, the IVA, and the BA; 2) crescendo ischemic attacks unresponsive to maximal medical management by intravenous heparin or antiplatelet medications, a minor stroke with persistence of symptoms or signs in the distribution of the stenotic artery, or an acute stroke caused by high-grade stenosis or total occlusion of the major intracranial arteries described above; 3) presence of symptoms within 6 months prior to treatment; or 4) a need of vascular reconstruction before general anesthesia (symptomatic or asympto-
The length of a lesion and the diameter of the vessel at the referential or stenotic site were measured on arteriograms obtained with the lesion positioned at the isocenter. Because images obtained with digital subtraction angiography in our institution showed lesions to be 1.4 times larger at the isocenter, a 14-mm scale was placed on an image-intensifier entrance plane with a grid to indicate a 10-mm scale on the angiograms.

Note.—DICA indicates distal internal carotid artery; IVA, intracranial vertebral artery; BA, basilar artery; rTIAs, recurrent transient ischemic attacks.
Results

The baseline angiogram showed a pre-CAS stenosis of 81 ± 16% in 12 lesions. A coronary stent was implanted easily in 10 of the 12 lesions, and eight of the 10 patients were treated successfully with stenting. In the 10 lesions successfully treated, a pre-CAS stenosis of 80 ± 17% was reduced to 7 ± 7% (P < .001) on the immediate post-CAS angiogram (Figs 1–3). In one patient (case 6), the expansion of a 3.0-mm gfx stent implanted in the left IVA was inadequate, and a 3.5-mm Ranger balloon was used to further expand both the stent and the lesion. In another patient (case 7), the expansion of a 3.5-mm Multilink stent implanted in the right distal ICA was not adequate, and a 4.0-mm NC VIVA balloon with a length of 10 mm (Boston Scientific/SciMed) was used to further expand both the stent and the lesion. Procedural and clinical success rates were 83% (10/12) and 80% (8/10), respectively. No morbidity or mortality was encountered. The two failures (one in the IVA and one in the BA) occurred because neither the balloon nor the stent catheter could be navigated to the lesion owing to extremely tortuous proximal arterial segments. Consequently, 10 lesions in eight patients were eligible for arteriographic follow-up. All eight patients in whom arteriography was successful underwent arteriographic follow-up 3 months after the procedure (100% follow-up). The diameter stenosis rate at that time was 19 ± 9%, which increased by 12% relative to the immediate post-CAS angiogram (P < .001) (Fig 4). No arteriographic restenosis occurred at 3 months. No transient ischemic attacks or strokes occurred during the 11 months’ (average) follow-up period.

Discussion

Our results suggest that CAS is a safe and effective means for treating intracranial atherosclerotic lesions of the vertebrobasilar artery and the distal ICA, and that short-term arteriographic or clinical outcome after CAS is favorable.

Anticipation of the likelihood of a successful procedure is required before performing elective PTCBA. A cerebral arteriographic classification (12, 13) has categorized lesions by their length and geometry as follows: type A, short (5 mm or less in length), concentric or moderately eccentric, and less than totally occlusive; type B, tubular (5–10 mm in length), extremely eccentric, and moderately angulated (curved), or chronic and totally occlusive for less than 3 months; and type C, diffuse (>10 mm in length), extremely angulated (>90°) with an excessively tortuous proximal segment, or chronic and totally occlusive for 3 months or longer. Before
Fig 2. Case 6.
A and B, Anteroposterior (A) and lateral (B) views of the left vertebral arteriogram immediately after CAS show sufficient and smooth dilatation of both lesions.
C and D, Anteroposterior (C) and lateral (D) views of the left vertebral arteriogram 3 months after CAS show no restenosis of either lesion.

Fig 3. Case 7.
A, Lateral view of the right carotid arteriogram before stent placement reveals a tubular (11.4 mm in length) and eccentric stenosis (82%) (arrow) of the distal ICA. Scale: 10 mm.
B, Lateral radiograph shows a 4.0-mm NC VIVA balloon catheter further expanding the 3.5-mm Multilink stent in the right distal ICA (arrow).
C, Lateral view of the right carotid arteriogram immediately after stent placement shows sufficient and smooth dilatation of the lesion.
D, Lateral view of the right carotid arteriogram 3 months after stent placement shows no restenosis.
CAS, 12 lesions in the present study were categorized according to those arteriographic characteristics: eight were classified as type B, two as type C, and two produced acute total occlusion (see Table).

A previous study (13) reported that the clinical success rates of standard elective PTCBA for type B and C lesions were 86% and 33%, respectively. Arteriographic restenosis rates 1 year after elective PTCBA for type B and C lesions were 33% and 100%, respectively. Cumulative risks of fatal or nonfatal ipsilateral ischemic stroke 1 year after elective PTCBA for type B and C lesions were 12% and 56%, respectively. For lesions in the type B and C groups, procedural complications and restenosis limited in-hospital and long-term arteriographic and clinical outcomes. To avoid abrupt closure or symptomatic dissection and to retain long-term patency, we made an attempt to apply a coronary stent in the type B and C lesions and in the cases of acute total occlusion that seemed to be unresponsive to standard PTCBA. The GFX and Multilink coronary stents, which have good flexibility and are of an appropriate length to follow arterial tortuosity, can be made to conform to vascular morphology. In addition, their struts, with wide openings, do not seem to occlude side branches, such as perforating arteries. The Ranger coronary balloon catheter, with its good flexibility, tractability, and over-the-wire system, was used to predilate the intracranial lesions. The clinical success rate of CAS was 83% (10/12), and the arteriographic restenosis rate was 0% (0/10) at 3 months. Cumulative risk of fatal or nonfatal ipsilateral ischemic stroke after CAS was 0% at 6 months. As compared with standard elective PTCBA for type B or C lesions, CAS with flexible coronary stents seems to yield favorable in-hospital and short-term arteriographic and clinical outcomes.

Conclusion

CAS with flexible balloon-expandable stents may prove to be a safe and effective means for treating intracranial atherosclerotic lesions of the verteobasilar artery and the distal ICA, and may yield a favorable short-term arteriographic and clinical outcome. Our results warrant further investigation of CAS and stent technology.

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