Indications and Problems of Intracranial Stenting

Report of Two Cases

J. DEGUCHI, T. KUROIWA, S. NAGASAWA, G. SATOH, T. OHTA

Department of Neurosurgery, Osaka Medical College, Osaka

Key words: intracranial artery, stent, chronic total occlusion

Summary

There have been few reports of stenting in the intracranial arteries. We used coronary stents in the chronically occluded intracranial vertebral artery and stenosis of internal carotid artery by the external force, and good blood flow were resumed. Stenosis in the intracranial arteries is also a good indication for stent placement when it is due to chronic total occlusion or artery compression by external force. But stent placement in the intracranial arteries has some problems. Stent placement in the intracranial artery is indicated only when the site of stent placement has a diameter of 3 mm or more, is a relatively linear portion of the vertebrobasilar artery or the internal carotid artery proximal to the C3 segment, and does not branch off perforating arteries or is already completely occluded.

Introduction

Neurosurgical operation for occlusive intracranial cerebral artery still has some problems. Low-flow bypass using a scalp artery such as the superficial temporal artery as a donor is relatively safe and easy, but its effects are unclear¹⁵. High-flow bypass using vessels such as the saphenous vein is technically difficult and has a high risk^{12,17}. Compared with these techniques, percutaneous transluminal angioplasty (PTA) by neuroradiological intervention

allows recovery of the original blood flow. The blood flow interruption time during operation is only several tens of seconds. This method can be performed under local anesthesia and even in patients with a poor general condition. However, PTA is performed in limited cases at only a few institutions because of many risks such as vascular rupture due to dissection and restenosis^{2,5,14}. Stenting has been widely performed in the coronary or peripheral arteries to overcome these problems, and good results have been reported⁴. However, there have been few reports in the intracranial arteries^{6,9,10}. We report 2 patients with intracranial artery occlusion treated using a stent and discussed the indications and problems of stent placement in the intracranial arteries.

Case 1

A 67-year-old man suddenly felt general fatigue and deafness on the left side. He could not stand. When he admitted our hospital, he represented disorientation and truncal ataxia without nystagmus, and was hard to walk. MRI showed a infarction in the left cerebellar peduncle. Cerebral angiography revealed the occlusion of the left vertebral artery, and 75% stenosis of right vertebral artery proximal to the origin of the posterior inferior cerebellar artery (figure 1A). Since, chest X-ray film revealed a lung cancer, we treated conservatively

Figure 1

for the cerebellar infarction. His symptom worsened two months later, and he became unable to sit on his bed. Brain computed tomographic (CT) scan revealed new scattered infarctions in bilateral cerebellar hemispheres. Only medical treatment was not enough to prevent for progression of the symptom. Cerebral angiography revealed occlusion of the right vertebral artery (figure 1B), and retrograde filling of the basilar artery from posterior communicating arteries. After superselective intraarterial injection of the Urokinase (480000 I.U), we performed PTA by FasSTEALTH balloon catheters (2 mm balloon 2 atm 30 s, 4 atm 30 s, 2.5 mm balloon 6 atm 60 s 2 times, 3 mm balloon 6 atm 60 s 2 times). After PTA, the residual stenosis was about 30% (figure 1C). Aspirin and ticlopidine were administered, and his symptom gradually improved. A month after PTA, the patient presented with dysarthria and right hemiparesis. Cerebral angiography revealed re-occlusion of the right vertebral artery, and distal vertebral artery and right posterior inferior cerebellar artery were fed

through anterior spinal artery (figure 1D).

We performed PTA again (2 mm balloon 6 atm 60 s, 3 mm balloon 6 atm 60 s 2 times). Because PTA was considered insufficient to prevent re-occlusion of the right vertebral artery, Cordis stent (3 mm/16 mm) was placed in the stenotic lesion after PTA and was dilated in 30-seconds increments to a final maximum of 8 atm (figure 1E). The symptom was not changed during and after the procedure.

Case 2

A 45-year-old man was performed transsphenoidal approach (Hardy's operation) for his recurrent pituitary adenoma. During the operation, his left internal cerebral artery (ICA) was injured, and Oxygel was packed in the left cavernous sinus for hemostasis. After operation, the patient presented right hemiparesis, and cerebral angiography revealed a stenosis at the intracavernous segment of left internal carotid artery by the packed Oxygel (figure 2A). First, we performed conservative

Figure 1 Case 1. A) Right vertebral angiogram on admission shows a 75% stenosis (arrow) at the proximal to the origin of the posterior inferior cerebellar artery. B) Two months after admission, right vertebral angiogram, anterior-posterior view, shows occlusion of the right vertebral artery (arrow). C) Right vertebral angiogram after PTA shows that the residual stenosis is about 30% (arrow). D) One month after PTA, right vertebral angiogram, anterior-posterior view, shows re-occlusion of the vertebral artery. Distal vertebral artery and right posterior inferior cerebellar artery are represented through anterior spinal artery (arrow). E) Placement of a Cordis stent (3 mm/16 mm) makes an adequate lumen (arrows).

therapy (systemic heparinization and induced hypertensive therapy), but his symptom was worsened and represented total aphasia and right hemiplegia 9-hours after the Hardy's operation. Therefore we suggested a EC-IC bypass to his family, but they refused neurosurgical intervention. Therefore we decided to perform neuroradiological intervention. Under local anesthesia, PTA was performed by FasSTEALTH balloon dilatation catheter (2.5 mm / 1 cm, 6 atm, 1 min, 4 times). Elastic recoil occurred on the stenotic internal carotid artery due to strong compression by the packing Oxycel (figure 2B). The stenotic lesion needed to be supported from inside. The stiff microguidewire (Choice plus floppy 0.014 inch) was passed through the stenotic lesion, and an AVE gfx stent (4.0 mm / 12 mm) was placed from the origin of the ophthalmic artery to the cavernous segment of the internal carotid artery. The stent was slowly dilated in 1-minute increments to final maximum 6 atm. Because increasing the balloon pressure the stent straightened the internal carotid artery, the stent dilatation was insufficient. Therefore the balloon was exchanged to a Ranger percutaneous transluminal coronary angioplasty balloon (4.0 mm/20 mm), and the proximal part of the gfx stent was dilated twice in 30 seconds for 6 atm. Still slight stenosis was remained, but the antegrade blood flow of the internal carotid artery recovered (figure 2C). Two months after neuro-radiological intervention, his aphasia, hemiparesis, and double vision were disappeared, and only bitemporal hemianopsia before the Hardy's operation was remained. The follow-up angiography, 8 months after PTA with stenting, revealed a good patency of the gfx stent. Because a pseudoaneurysm was revealed on the injured portion of the internal carotid artery at the same time, we embolized that pseudoaneurysm by GDC coils (figure 2D).

Discussion

Neurosurgical operation for occlusive intracranial cerebral artery disease still has some problems. Low-flow bypass for occlusion of the internal cerebral artery using vessels such as the superficial temporal artery as a donor is relatively safe and easy, but its effects are unclear¹⁵. However, low-flow bypass for unstable vertebrobasilar insufficiency is not safe with a peri-

operative mortality rate of 15% and a morbidity rate of 26%¹. In addition, high-flow bypass using vessels such as the saphenous vein is technically difficult and very risky, requiring adequate preoperative evaluation such as a balloon occlusion test^{12,17}.

On the other hand, PTA of the intracranial arteries can be performed under local anesthesia, is less invasive, and allows recovery of the original blood flow if dilatation is adequate^{2,5}. In addition, it can be performed even in complete occluded arteries if the period from occlusion is within 3 months⁸, and there have been many reports of PTA for chronic total occlusion in the coronary arteries. However, this condition is an indication for coronary stenting^{11,13}, due to a high risk of restenosis¹⁶. In Case 1, antegrade blood flow recovered after only PTA, but re-occlusion occurred after 1 month. Therefore, we planned stent placement in the artery.

Artery compression by external force has been conventionally treated by either removal of the compressing mass or bypass operation. In Case 2, removal of the packing mass was impossible, and as described above, the usefulness of bypass operation was questionable. Since PTA alone was suspected to result in restenosis after a short period, a stent was placed. The radial force of the stent was strong, preventing stenosis. Thus, stenosis in the intracranial arteries is also a good indication for stent placement when it is due to chronic total occlusion or artery compression by external force.

Stent placement in the intracranial vessels has some problems. 1) Since the intracranial vessels are tortuous, whether the stent can reach the target site is a problem. To solve this problem, we recently used highly flexible stents such as the Cordis stent, AVE gfx stent, and NIR stent⁷. However, even if a coronary stent is used, stent placement beyond the C3 segment of the carotid syphon is difficult.

2) The stent does not open unless high pressure dilatation. In many areas, there are no supportive tissue around in the intracranial arteries, and therefore, straightening of the balloon and stent during dilatation may cause pull-back injury in the perforating branches. Thus, a stent and balloon that are also conformable during balloon dilatation are necessary.

3) Restenosis may also occur after stent placement. The incidence of restenosis increases when the diameter at the stent placement

Figure 2 Case 2. A) After Hardy's operation, left carotid angiography shows sever stenosis at the intracavernous segment of left internal carotid artery by the packed Oxytel. B) After PTA, left carotid angiogram shows elastic recoil occurred on the stenotic internal carotid artery due to strong compression by the packing Oxytel. C) After PTA with stenting, left carotid angiogram shows the antegrade blood flow but residual stenosis on the distal portion of the gtx stent (arrows). D) 8 months after PTA with stenting, left carotid angiogram shows a good patency of the gtx stent. At the same time, Because a pseudoaneurysm was revealed on the injured portion of the internal carotid artery, we embolized that pseudoaneurysm by GDC coils (arrow).

site is less than 3 mm¹³. In the future, this problem might be overcome by improvement in the stent material and drug therapy.

4) There is a risk of impairing the blood flow of the perforating branches from the stent strut. There have been no studies on the blood flow of the perforating branches from the stent placement site. In Case 1, since the stent location was proximal to the posterior inferior cerebellar artery, no new effects on the perforating arteries were expected because of occlusion, and stent placement was considered to be possible. Therefore, stent placement in the intracranial artery is indicated only when the site of stent placement has a diameter of 3 mm or more, is a relatively linear portion of the verte-

brobasilar artery or the internal carotid artery proximal to the C3 segment, and does not branch off perforating arteries or is already completely occluded.

Conclusions

Stents were placed in the occluded intracranial arteries, and good blood flow was resumed. This method is an epoch-making method that is minimally invasive and allows recovery of the original blood flow. However, at present, this method is only another surgical vascular reconstruction method because of risks of restenosis and occlusion of perforating arteries.

References

- 1 Ausman JJ, Diaz FG et Al: Superficial temporal and occipital artery bypass pedicles to superior, anterior inferior, and posterior inferior cerebellar arteries for vertebrobasilar insufficiency. *J Neurosurg* 72: 554-558, 1990.
- 2 Clark WM, Barwell SL et Al: Safety and efficacy of percutaneous transluminal angioplasty for intracranial atherosclerotic stenosis. *Stroke* 26: 1200-1204, 1995.
- 3 Connors III JJ, Wojak JC: Percutaneous transluminal angioplasty for intracranial atherosclerotic lesions: evolution of technique and short-term results. *J Neurosurg* 91: 415-423, 1999.
- 4 Gruentzig AR, King III SB et Al: Long-term follow-up after percutaneous transluminal coronary angioplasty. The early Zurich experience. *N Engl J Med* 316: 1127-32, 1987.
- 5 Higashida RT, Tsai FY et Al: Transluminal angioplasty for atherosclerotic disease of the vertebral and basilar arteries. *J Neurosurg* 78: 192-198, 1993.
- 6 Horowitz MB, Pride GL et Al: Percutaneous transluminal angioplasty and stenting of midbasilar stenoses: Three technical case reports and literature review. *Neurosurgery* 45: 925-931, 1999.
- 7 Lanzino G, Wakhloo AK et Al: Efficacy and current limitations of intravascular stents for intracranial internal carotid, vertebral, and basilar artery aneurysms. *J Neurosurg* 91: 518-546, 1999.
- 8 Mori T, Fukuoka M et Al: Follow-up study after intracranial percutaneous transluminal cerebral balloon angioplasty. *Am J Neuroradiol* 19: 1525-1533, 1998.
- 9 Mori T, Kazita K, Mori K: Cerebral angioplasty and stenting for intracranial vertebral atherosclerotic stenosis. *Am J Neuroradiol* 20: 787-789, 1999.
- 10 Morris PP, Martin EM et Al: Intracranial deployment of coronary stents for symptomatic atherosclerotic disease. *Am J Neuroradiol* 20: 1688-1694, 1999.
- 11 Rubartelli P, Niccoli L et Al: Stent implantation versus balloon angioplasty in chronic coronary occlusions: Results from the GISSOC trial. *J Am Coll Cardiol* 32: 90-96, 1998.
- 12 Sen C, Sekhar LN: Direct vein graft reconstruction of the cavernous, petrous, and upper cervical internal carotid artery: Lessons learned from 30 cases. *Neurosurgery* 30: 732-743, 1992.
- 13 Sirnes PA, Golf S et Al: Sustained benefit of stenting chronic coronary occlusion: Long-term clinical follow-up of the stenting in chronic coronary occlusion (SICCO) study. *J Am Coll Cardiol* 32: 305-310, 1998.
- 14 Takis C, Kwan ES et Al: Intracranial angioplasty: Experience and complications. *Am J Neuroradiol* 18: 1661-1668, 1997.
- 15 The EC/IC bypass study group: Failure of extracranial-intracranial arterial bypass to reduce the risk of ischemic stroke. *N Engl J Med* 313: 1191-1200, 1985.
- 16 Violaris AG, Melkert R, Serruys PW: Long-term luminal renarrowing after successful elective coronary angioplasty of total occlusions: A quantitative angiographic analysis. *Circulation* 91: 2140-2150, 1995.
- 17 Vishteh AG, Marciano FF et Al: Long-term graft patency rates and clinical outcomes after revascularization for symptomatic traumatic internal carotid artery dissection. *Neurosurgery* 43: 761-768, 1998.

Jun Deguchi, M.D.
Department of Neurosurgery
Osaka Medical College
2-7 Daigaku-machi, Takatsuki
Osaka 569-8686, Japan