Treatment of Cervical Carotid Artery Stenosis

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Summary

As treatment for cervical carotid artery stenosis, medical treatment, carotid endarterectomy (CEA), and percutaneous transluminal angioplasty (PTA) with/without stenting are known. In this report, we review the history and current status of these treatments.

Comparison between CEA and PTA/stenting is further discussed based on recent clinical reports and evidence.

History of treatment for carotid artery stenosis A short review

Carotid endarterectomy (CEA)

Stenosis of the cervical carotid artery causes cerebral ischemia by two different mechanisms, cerebral embolism and haemodynamic ischemia. Chiari et Al reported in 1905 that cerebral embolism occurs due to 'endarteritis chronica deformans'. Carrea et Al reported that end-to-end anastomosis of the carotid artery after resection of the stenotic lesion at 1951. The first thromboendarterectomy was performed for occlusion of the internal carotid artery (ICA)¹. Afterward, numerous reports are available regarding carotid endarterectomy for ICA stenosis and thromboendarterectomy for ICA occlusion.

In 1991, the result of very important trials, North American Symptomatic Carotid Endarterectomy Trial (NASCET), was reported². In that report, benefit of carotid endarterectomy for patients with high-grade stenosis of the internal carotid artery was reported. Later, the result of 'Endarterectomy for asymptomatic carotid artery stenosis trial' was also reported³. However, it is noteworthy that temporary/permanent complications (20.4%) other than stroke occurred after CEA in NASCET trials. Two third patients were excluded for CEA in the trial.

Percutaneous transluminal angioplasty (PTA)

On the other hand, PTA using a balloon catheter was first performed by Gruntzig at 1974. In 1980's, PTA was performed for cervical carotid artery stenosis. However, it was not regarded as an alternative treatment due to thromboembolic complication and high rate of restenosis after the procedures.

Carotid artery stenting (CAS)

In 1996, Yadav et Al reported their experience of stenting for carotid artery stenosis⁴. In stenting for ICA, it is important to reduce the risk of distal embolism during procedure as well as to prevent restenosis after treatment. Regarding restenosis, stent application for ca-

rotid artery stenosis seemed to reduced restenosis after treatment⁴. However, it was not possible to prevent distal embolism in simple stenting procedure.

Cerebral protection systems for CAS

Recently, cerebral protection system was developed and its efficacy during stenting for carotid stenosis has been reported^{5,6}. Three methods are currently available, distal protection with balloon, distal protection with filters, and proximal protection with double balloons. In proximal protection system, both the ICA and ECA should be occluded simultaneously to stop blood flow in the ICA.

Among the distal protection system, PercuSurge GuardWire Plus (Medtronic) has been widely used recently⁷. In this system, protection balloon is mounted on the 0.014-inch guidewire, and the maximum diameter of the balloon is 6 mm. This system is usually used with a special catheter for aspiration of the emboli. If the balloon is dilated enough throughout the procedure, it is possible to collect the emboli by aspiration of the 40 to 60 ml of blood in the ICA.

Another distal protection system employs

filter device, such as ANGIOGUARD or Filter Wire XP (Boston Scientific). In these systems, a filter for capturing the emboli is mounted on the guidewire.

For proximal protection, PAES (Parodi Anti Emboli system) is used^{8,9}. In this system, the origin of the ECA and the ICA are occluded with balloons, and the retrograde flow from the carotid artery are collected into the guiding catheter, filtered, and returned into the femoral vein. The emboli are captured in the filter, which is connected to the catheter.

These systems have merit and demerit. In balloon protection systems, usually all the emboli can be captured theoretically. However, the patients who are not tolerable for ICA occlusion, it is difficult to use this system. In contrast, since filter device does not occlude the ICA, it can be used for the intolerant patient for ICA occlusion. But in the tortuous vessel, the filter cannot capture all the emboli because of a gap between the filter and vascular wall.

In Global Carotid Stent Survey (2003), procedure-related stroke/death rate was 5.29% in unprotected group (n= 6753) and 2.23% in protected group (n = 4221)¹⁰.

Table 1 List of Ongoing Carotid Stent Trials

Trial	Stent	Protection	Patient Population	Pts/Ctrs	Date
CREST	AccuLink (Guidant)	AccuNet (Guidant)	PRCT symptomatic, any risk	2500/60	2005?
SAPPHIRE	Precise (Cordis)	Angioguard (Cordis)	PRCT w/Registry symptomatic, high risk	307/30 +409 (reg)	Q2,2003
ICCS CAVATAS2	AccuLink Carotid Wall SMART	Angioguard EPI MedNova PercuSurge ArteriA	PRCT symptomatic, any risk	200/30	?
CARESS	Carotid Wall	PercuSurge	non-RCT both, any risk	1800/30	Q2,2002
BEACH	Carotid Wall	EPI		776/40	Q2,2004
MAVERICK US	EXPONENT	PercuSurge Interceptor	Registry both, high risk	400/50	Q3,2004
SECURITY	X.act	MedNova		470/35	Q2,2003
ARCHeR	AccuLink	AccuNet		437/35	Q2,2003
CABERNET	Endotex	EPI		?	?

Clinical trials for carotid artery stenosis

Carotid and vertebral artery transluminal angioplasty study (CAVATAS)

The result of the randomized controlled trial (RCT) of the PTA and CEA for the carotid artery stenosis, Carotid And Vertebral Artery Transluminal Angioplasty Study (CAVATAS) was reported¹¹.

In this report, 504 surgically eligible patients were registered, and PTA with/without stenting was performed in 251 patients and CEA was performed in 253 patients and followed. Disabling stroke/death was observed in 6.4% in PTA group and 5.9% in CEA group. Cranial nerve palsy was 8.7% in CEA group, and 0% in PTA group. Wound hematoma was 6.7% in CEA group and 1.4% in PTA group. However, restenosis was observed more frequently in PTA group (14.0% in PTA, 4.0% in CEA). In this study, stents were only used in 55 of 251 patients (26%).

This is considered the reason of high rate of restenosis after the procedures. In other words, PTA was performed effectively and safely, and it was nearly equivalent to CEA under this condition (without any protection systems and limited population of stent use).

Carotid revascularization endarterectomy vs. stent trial (CREST)

Another RCT is ongoing named CREST (Carotid Revascularization Endarterectomy vs. Stent Trial). In this trial carotid artery stenting (CAS) and CEA are randomly performed in 2500 patients.

Stenting and angioplasty with protection in patients at high risk for endarterectomy (SAPPHIRE)

On the other hand, a RCT targeting the high risk patients for CEA named SAPPHIRE trial (Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy) was reported recently. This trial is randomized, multi-center trial comparing CAS with distal protection to endarterectomy in high surgical risk patients. Nitinol Stent System (PRECISE: Cordis) and the filter distal protection device (AN-

GIOGUARD XP) were employed. A total of 307 patients were randomized and CAS was performed in 156 patients and CEA was in 151 patients. A statistically significant difference was observed in death/stroke/MI at 30 days (12.6% in CEA, 5.8% in CAS: $p<0.05$). Further, there were significant differences at 1 year after the treatment in major ipsilateral stroke (3.3% in CEA, 0% in CAS: $p<0.05$), MI (7.9% in CEA, 2.9% in CAS: $p<0.05$), and major adverse events without non-neuronal death (12.6% in CEA, 5.7% in CAS: $p<0.05$). From this study, it is likely that the clinical results were better in CAS group in the high-risk patients for CEA.

Other trials

A lot of CAS trials with different are ongoing as shown (table 1). With results of these clinical trials, clinical indication of CAS and CEA would be affected in the future.

Future of CAS

Recently, drug-eluting stent (DES) has been developed so as to prevent restenosis after angioplasty. Rapamycin (Sirolimus) coated stent has been clinically used for coronary artery and dramatic preventive effect of restenosis after stenting was reported.

This coating was employed for self-expandable stent and clinically used femoral artery as SIROCCO Study (Sirolimus coated cordis SMART nitinol self-expandable stent for the treatment of obstructive superficial femoral artery disease). Preliminary results showed that this coated self-expandable stent is also effective to prevent restenosis after angioplasty of femoral artery. DES may be applicable for CAS in the near future.

Conclusions

Treatments for carotid artery stenosis were reviewed in this report. Recent RCT (SAPPHIRE) demonstrated that CAS was more effective and safer for the high-risk patients for CEA. Based on the other ongoing trials, indications and balances of CAS and CEA would be changed in the near future. A novel tool such as drug-eluting stent may affect the choice of treatment of carotid artery stenosis.

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