online © ML Comm
www.jkns.or.kr 10.3340/jkns.2010.47.6.428
Print ISSN 2005-3711 On-line ISSN 1598-7876
J Korean Neurosurg Soc 47 : 428-432, 2010

Clinical Article

Emergency Carotid Artery Stent Insertion for Acute ICA Occlusion

Hai Ong Lee, M.D., Eun Jeong Koh, M.D., Ph.D., Ha Young Choi, M.D., Ph.D.

Department of Neurosurgery, Research Institute of Clinical Medicine, Chonbuk National University Medical School and Hospital, Jeonju, Korea

Objective : An effective intervention has not yet been established for patients with acute occlusion of the internal carotid artery (ICA). The aim of our study was to investigate the feasibility, safety, and efficacy of emergent stent placement of carotid artery to improve neurologic symptoms and clinical outcome.

Methods : Of 84 consecutive patients with severe ICA stenosis who were admitted to our institution from March 2006 to May 2009, 10 patients with acute ICA occlusion (11.9%) underwent emergency carotid artery stent placement. We reviewed their records for neurologic outcome using the National Institutes of Health Stroke Scale (NIHSS) score, before and at 7 days after stent placement; clinical outcome using the modified Rankin Scale score (mRS) and Glasgow Outcome Scale (GOS); frequency of procedure-related complications; and recurrence rate of ipsilateral ischemic stroke within 90 days.

Results : Carotid lesions were dilated completely in all patients. Median NIHSS scores before emergency stent placement and at 7 days were 16.6 and 6, respectively, showing significant improvement. Eight patients (80%) had favorable outcomes (mRS score 0-2 and GOS 4-5). Complications occurred in two patients (20%): stent insertion failed in one and an intracerebral hemorrhage occurred in the other. Ipsilateral ischemic stroke did not recur within 3 months.

Conclusion : Emergency carotid artery stent placement can improve the 7-day neurologic outcome and the 90-day clinical outcome in selected patients with acute cerebral infarction.

KEY WORDS : Cerebral infarction · Carotid stenosis · Stent.

INTRODUCTION

Stroke is the most common and disabling neurologic disorder in the elderly population[17]. Carotid artery stenting (CAS) and carotid endarterectomy (CEA) are commonly performed revascularization procedures to prevent stroke in patients with severe carotid artery stenosis[20]. Until now, important landmark studies such as the North American Carotid Endarterectomy Trial (NASCET) and the Asymptomatic Carotid Atherosclerotic Study (ACAS) have found that surgical intervention is beneficial in reducing the relative risk in patients with significant carotid artery atherosclerotic disease[1].

• Received : April 5, 2010 • Revised : May 2, 2010
• Accepted : May 23, 2010
• Address for reprints : Eun Jeong Koh, M.D., Ph.D.
Department of Neurosurgery, Research Institute of Clinical Medicine, Chonbuk National University Medical School and Hospital, 664-14 Deokjin-dong, Deokjin-gu, Jeonju 561-756, Korea
Tel : +82-63-250-1870, Fax : +82-63-277-3273
E-mail : kohejns@jbnu.ac.kr

However, for patients with acute ischemic stroke who present with serious neurological deficits on admission or are neurologically aggravated due to total occlusion or a high-grade stenosis of the internal carotid artery (ICA) despite maximal medical treatment, an effective intervention to improve their neurologic symptoms and clinical outcome has not yet been established.

CEA has proved to be beneficial in the prevention of stroke recurrence in patients with a high-grade stenosis of the ICA, but emergency CEA carries the risk of decreasing cerebral blood flow (CBF) in the cerebral hemisphere during the operation and may render the affected hemisphere more vulnerable to ischemia. As an alternative to the traditional surgical treatment of carotid artery occlusive disease, there has been much interest in the use of carotid artery stent placement[17]. Endovascular specialists are becoming familiar with this stent placement procedure, which may be safe and effective even in the acute stage of ischemic stroke. Emergency carotid artery stent placement is expected to reopen a carotid occlusion or a critical stenosis with rare reduction in

CBF in the affected hemisphere during the procedure. We have performed this emergency procedure in patients with acute stroke to improve their neurologic symptoms and clinical outcome.

The purpose of our retrospective study was to investigate the feasibility, safety, and efficacy of emergency carotid artery stent placement.

Table 1. Patients' clinical profiles and clinical outcome

Case	Age/ Sex	Occlusion site	F/U duration (month)	NIHSS initial/7 days/90 days f/u	mRS initial/7 days/90 days f/u	GOS 7 days/90 days f/u
1	63/M	RT	36	8/4/3	4/2/2	4/4
2	65/M	LT	35	20/9/10	5/4/4	3/3
3	73/M	RT	26	14/4/3	4/2/1	4/4
4	59/M	RT	25	17/6/3	5/3/2	3/4
5	62/M	RT	16	17/2/1	5/1/1	5/5
6	62/M	LT	14	16/6/4	4/2/2	4/5
7	65/M	RT	13	20/8/9	5/2/2	4/4
8	78/F	RT	12	22/7/6	5/2/2	4/5
9	80/M	RT	12	13/6/6	5/2/2	4/4
10	65/M	RT	10	19/8/7	5/4/4	3/3

F : female, F/U : follow up, GOS : Glasgow Outcome Scale, M : male, mRS : modified Rankin Scale, NIHSS : National Institutes of Health Stroke Scale

MATERIALS AND METHODS

Patient population

Of 84 consecutive patients with acute ischemic stroke who were admitted to our institution within 7 days of onset from March 2006 to May 2009, 10 patients (11.9%) who showed acute occlusion of ICA and fulfilled our inclusion criteria underwent emergency carotid artery stent placement. A retrospective review was conducted of these cases.

Inclusion criteria

Before the emergency carotid artery stent placement, we checked four inclusion criteria. First, the patients should have admitted to our institution within 6 hours of the onset of stroke symptoms and had serious neurologic symptoms as defined by a National Institutes of Health Stroke Scale (NIHSS) score of 5 or more just before stent placement. Second, an magnetic resonance angiography (MRA) should have shown total occlusion of the ICA related to the neurologic symptoms. Third, there should have been a diffusion-perfusion mismatch of more than 30% on MR images. Fourth, the patients should have had faint visible collateral circulation on MRA. We then performed emergency carotid artery stent placement as soon as possible after admission in patients who fulfilled the four inclusion criteria.

Techniques of stent placement procedure

Emergency carotid artery stent placement was performed as soon as possible after admission in patients with sudden onset of severe stroke or after a diagnosis of progressing stroke. Transfemoral catheterization was performed, and a guide catheter was advanced by exchange technique to the common carotid artery proximal to the ICA occlusion. To facilitate sizing of balloons and stents, the vessel diameter was measured after calibration of the system with reference to the known length of the lead marker. A microguidewire (0.016-inch GT wire; Terumo, Tokyo, Japan) was inserted carefully advanced up to the distal ICA, and then a microcatheter (Transit 2; Cordis Endovascular, Johnson & Johnson, New Brunswick, NJ, USA) was navigated across the carotid occlusion over the wire. After the 180-cm microguidewire was exchanged with a 300-cm-long microguidewire (0.014 inch, Right Away Super Hard; Piolax, Kanagawa, Japan), the microcatheter was replaced by a lowprofile 3.0- or 3.5-mm balloon catheter (Ranger or Gateway; Boston Scientific, Natick, MA, USA), which was used to moderately dilate the carotid stenosis. A self-expandable stent (Easy Wallstent; Boston Scientific) or a balloon-expandable stent (S670; Medtronic Inc., Minneapolis, MN, USA or NIR Elite; Boston Scientific) was deployed over the residual stenosis. Stents were selected by referring to the diameter of the ICA just distal to the carotid stenosis. In case of a narrow distal ICA or tortuosity of the proximal carotid artery, a balloon-expandable stent with a small and flexible shaft was inserted. Then a balloon catheter with a larger diameter was positioned in the stent site and inflated large enough to dilate stents and the carotid artery. After deployment of stents, the stent site as well as the distal ICA and the MCA were evaluated angiographically.

Management after emergency stent placement

After the procedure, 10 mg of a direct thrombin inhibitor (Argatroban) was administered intravenously over 2 hours twice daily for 7 days. Each patient was monitored closely in the intensive care unit for 24 hours with strict blood pressure control. After 7 days, all patients received two antiplatelet agents orally or through a gastrointestinal tube : aspirin 100 mg/day and Plavix 100 mg/day. Brain CT was performed immediately, at 24 hours, and at 7 days after the procedure.

Outcome measures

For all 10 patients who underwent emergency stent placement, pertinent medical records and imaging studies were

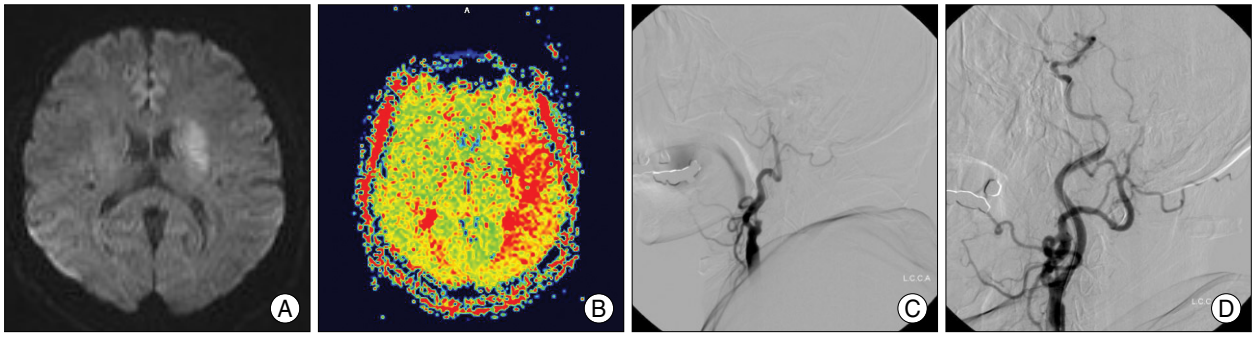

Fig. 1. Brain MRI of 65-year-old man who showed right side weakness and aphasia. A : Diffusion weighted MRI showing acute cerebral infarction of the left basal ganglia. B : Perfusion weighted MRI reveals severe perfusion decrease on the left cerebral hemisphere except posterior circulation area. C : DSA presenting total occlusion of the left ICA. D : DSA showing recanalization of left ICA after stent insertion.

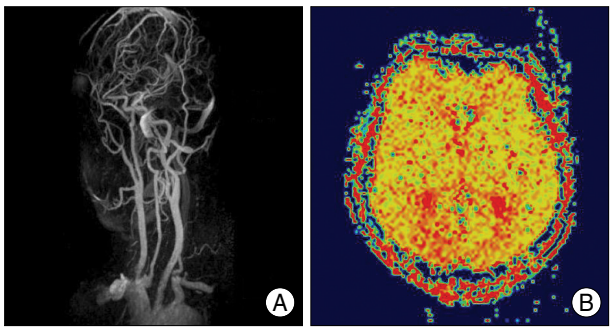

Fig. 2. Follow up MRI and MRA showing that stent insertion site is patent without restenosis (A) and no perfusion decrease in left cerebral hemisphere (B).

reviewed to evaluate neurologic outcome per the NIHSS score, clinical outcome per the modified Rankin Scale (mRS) score, Glasgow Outcome Scale (GOS) and frequency of procedure-related complications within 7 days and at 90 days follow-up.

RESULTS

Among the 10 patients who underwent emergency carotid artery stent placement at our institution (Table 1), 9 patients were male and 1 patient was female, and ages ranged from 59 to 80 years (mean, 67.2 years). Mean follow up duration was 19.9 months. Diffusion-perfusion mismatching was noted in all patients. On angiogram, all patients showed ICA total occlusions. In all patients, the cause of the ICA stenosis or occlusion was considered to be atherothrombosis (Fig. 1).

The technical success rate was 90%, with 10 carotid arteries treated (Fig. 2). Stent insertion failed in only one patient. Median NIHSS scores before, at 7 days after stent insertion and at 90 days follow-up were 16.6, 6 and 5.2. Eight patients (80%) had favorable outcomes [modified Rankin Scale (mRS) 0-2, GOS 4-5], and two patients (20%) had severe disability (mRS score over than 4) at 7 days. A clinically good outcome 90 days after stent insertion was estimated by mRS and GOS in 80% (8 out of 10) of the patients.

Complication occurred in two patients (20%) : a failed stent insertion in one patient and an intracranial hemorrhage in the other patient. For the latter, the patient did not have any further neurological deterioration because the ICH was located in the necrotic core. Ipsilateral ischemic stroke recurrence did not occur within 90 days of the emergency stent insertion procedure.

DISCUSSION

The natural history of carotid-related ischemic stroke is unclear. According to a review by Meyer et al.[9], the prognosis for patients with acute stroke with carotid occlusion is poor : 40-69% of these patients are permanently disabled, 16-55% died of the stroke, and only 2-12% had a good recovery. Recent data have conclusively shown that patients benefit the most when intervention is performed early (within 2 weeks after the index event) to prevent recurrent stroke, even though the procedural risk may be higher[10,12,14]. For patients with acute ischemic stroke due to total occlusion of the ICA, an effective intervention to improve neurologic symptoms and clinical outcome has not yet been established[13]. In previous reports, early CEA or carotid artery stent placement improved neurologic symptoms of acute ischemic stroke patients[4-9,13,16]. Ekstein et al.[2] reported that major stroke-free survival was 53.7% after 5 years in acute ischemic stroke patients who underwent emergency CEA. In a six-month follow-up study by Hoppe et al.[6] on patients who were treated by emergent carotid artery stent insertion, 15 of the 16 living patients demonstrated a widely patent stent-graft. Although we have a relatively short mean follow-up duration, 8 out of 10 patients showed favorable outcomes in our study.

From the NASCET study, it is important to note that other significant morbidities included a 9% incidence of

wound complication such as hemorrhage and infection, 8.6% incidence of cranial nerve palsy, and an 8.1% 30-day medical complication rate, most of which prolonged hospitalization[1,3]. Risk of CEA is presumably due to vessel manipulation prior to establishment of arterial cross-clamp. In contrast, carotid artery stenting can establish proximal protection before any manipulation of vascular stenosis or intraluminal thrombus[8]. In the present study, only one procedure-related complication occurred (10%). There were no ipsilateral transient ischemic attack (TIA) or acute ischemic stroke recurrences within 90 days, whereas morbidity rates of 6.3-9.9% have previously been reported in studies of emergency CEA[11,18]. The risks of carotid stent placement are comparable to the American Heart Associations (AHA) guidelines for carotid endarterectomy : less than 6% for patients with TIAs and less than 7% for patients with symptomatic strokes[11,18].

Of the 10 patients in the present study, 8 (80%) recovered or were considered to have a non-disabling stroke at 7 days after emergency carotid artery stent placement. These results are better than those previously reported, and NIHSS scores at 7 days after emergency stent placement showed significant improvement from baseline scores. Setacci et al.[15] revealed that endovascular treatment provided a satisfactory outcome considering the very high risk profile of the patient population (at 30 days : death 2.3%, TIA/stroke 2.3%). Thus, in this small study, emergency carotid artery stent placement revealed favorable outcomes in patients who presented with acute ischemic symptoms with ICA occlusion. More study is required to determine the role of this therapy in the treatment of patients with acute ischemic stroke and significant ipsilateral carotid artery stenosis or occlusion.

Despite the poor signs of growth for CAS within the past few years, it is important to remember several points. First, CAS is a new procedure done by varying specialties with different levels of training, involving one of the most demanding areas of the human body. Second, the development of new materials (distal embolic filters and variable stents, etc.) improve ease of use and effectiveness. However, it is important to remember that surgery is as good as it will get and stenting will only get better[19].

CONCLUSION

We treated the acute ICA occlusion patient who fulfilled our inclusion criteria with emergency carotid artery stent insertion. Although we have a relatively short follow-up period and a small number of patients, emergency carotid artery stent placement seemed to improve neurologic outcome in patients with acute ischemic stroke from acute ICA total occlusion.

• Acknowledgements
The authors thank to Prof. Hyo Sung Kwak, the Department of Radiology, Chonbuk National University Medical School/Hospital for his great help during this work.

References

1. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. North American Symptomatic Carotid Endarterectomy Trial Collaborators. **N Engl J Med 325** : 445-453, 1991
2. Eckstein HH, Schumacher H, Klemm K, Laubach H, Kraus T, Ringleb P, et al. : Emergency carotid endarterectomy. **Cerebrovasc Dis 9** : 270-281, 1999
3. Ferguson GG, Eliasziw M, Barr HW, Clagett GP, Barnes RW, Wallace MC, et al. : The North American Symptomatic Carotid Endarterectomy Trial : surgical results in 1415 patients. **Stroke 30** : 1751-1758, 1999
4. Geisler BS, Röther J, Kucinski T, Zeumer H, Eckert B : Emergency carotid artery stenting in persistent hemodynamic deficit associated with severe carotid stenosis. **AJNR Am J Neuroradiol 26** : 549-552, 2005
5. Gröschel K, Knauth M, Ernemann U, Pilgram SM, Schnaudigel S, Kastrup A : Early treatment after a symptomatic event is not associated with an increased risk of stroke in patients undergoing carotid stenting. **Eur J Neurol 15** : 2-5, 2008
6. Hoppe H, Barnwell SL, Nesbit GM, Petersen BD : Stent-grafts in the treatment of emergent or urgent carotid artery disease : review of 25 cases. **J Vasc Interv Radiol 19** : 31-41, 2008
7. Imai K, Mori T, Izumoto H, Watanabe M, Majima K : Emergency carotid artery stent placement in patients with acute ischemic stroke. **AJNR Am J Neuroradiol 26** : 1249-1258, 2005
8. Jahromi BS, Tummala RP, Yamamoto J, Levy EI, Siddiqui AH, Hopkins LN : Early carotid stenting for symptomatic stenosis and intraluminal thrombus presenting with stroke. **Neurology 71** : 1831-1833, 2008
9. Meyer FB, Sundt TM Jr, Piepgras DG, Sandok BA, Forbes G : Emergency carotid endarterectomy for patients with acute carotid occlusion and profound neurological deficits. **Ann Surg 203** : 82-89, 1986
10. Mussa FF, Aaronson N, Lamparello PJ, Maldonado TS, Cayne NS, Adelman MA, et al. : Outcome of carotid endarterectomy for acute neurological deficit. **Vasc Endovascular Surg 43** : 364-369, 2009
11. Moore WS, Barnett HJ, Beebe HG, Bernstein EF, Brener BJ, Brott T, et al. : Guidelines for carotid endarterectomy. A multidisci-plinary consensus statement from the ad hoc Committee, American Heart Association. **Stroke 26** : 188-201, 1995
12. Naylor AR : Delay may reduce procedural risk, but at what price to the patient? **Eur J Vasc Endovasc Surg 35** : 383-391, 2008
13. Papanagiotou P, Roth C, Grunwald IQ, Ahlhelm F, Ernst N, Haass A, et al. : [Carotid artery stenting for acute stroke.] **Radiologe 49** : 335-339, 2009
14. Rothwell PM, Eliasziw M, Gutnikov SA, Warlow CP, Barnett HJ; Carotid Endarterectomy Trialists Collaboration : Endarterectomy for symptomatic carotid stenosis in relation to clinical subgroups and timing of surgery. **Lancet 363** : 915-924, 2004
15. Setacci C, de Donato G, Chisci E, Setacci F : Carotid Artery Stenting in Recently Symptomatic Patients : a single center experience. **Ann Vasc Surg 24** : 474-479, 2010
16. Setacci C, de Donato G, Chisci E, Setacci F : Rationale and design of emergent/urgent carotid artery stenting (EUCAS) registry. **J Cardiovasc Surg (Torino) 49** : 737-742, 2008

17. Wholey MH, Wholey MH, Jarmolowski CR, Eles G, Levy D, Buecthel J : Endovascular stents for carotid occlusive disease. **J Endovasc Surg 4** : 326-338, 1997
18. Wholey MH, Wholey M, Mathias K, Roubin GS, Diethrich EB, Henry M, et al. : Global experience in cervical carotid artery stent placement. **Catheter Cardiovasc Interv 50** : 160-167, 2000
19. Wholey MH, Wu WC : Current status in cervical carotid artery stent placement. **J Cardiovasc Surg 50** : 29-37, 2009
20. Zhou W, Dinishak D, Lane B, Hernandez-Boussard T, Bech F, Rosen A : Long-term radiographic outcomes of microemboli following carotid interventions. **J Vasc Surg 50** : 1314-1319, 2009