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Letter to the Editor

Surgical Treatment of Carotid Arterial Stenosis

Tetsuya Tsukahara*

Department of Neurosurgery, National Hospital Organization, Japan

***Corresponding author:** Tetsuya Tsukahara, Department of Neurosurgery, National Hospital Organization, Kyoto Medical Center, 1-1 Mukaihata-cho, Fushimi-ku, Kyoto 612-8555, Japan

Received: May 15, 2014; **Accepted:** May 19, 2014; **Published:** May 21, 2014

Abstract

There are two surgical therapeutic methods for the treatment of carotid stenosis, Carotid Endarterectomy (CEA) and Carotid Artery Stenting (CAS), although the indications of these two methods have not been fully established. This report suggests an appropriate treatment strategy for carotid stenosis based on our clinical results after CEA and CAS.

CEA has been considered the first choice for the surgical treatment of severe carotid stenosis, especially with an eccentric or tortuous lesion, and a narrow residual lumen with abundant soft plaque. CAS has been chosen on considering CEA to be high-risk with a contra lateral ICA lesion, distal carotid lesion, or medical risk factors, such as untreated coronary heart disease. From January 2001 to December 2009, we treated cervical carotid stenosis patients surgically as follows: 171 lesions by CEA and 251 lesions by CAS. Surgical mortality with CEA and CAS was 0.6% (1/171) and 0.4% (1/251), respectively. Surgical morbidity with ischemic stroke of CEA and CAS was 2.9% (5/171) and 2.4% (6/251), respectively. Carotid stenotic lesions can be treated with comparably low morbidity and mortality rates using CEA and/or CAS even in high-risk patients, when appropriate surgical methods are selected considering each characteristic of the stenotic lesions and the carotid plaque.

Keywords: Carotid Endarterectomy (CEA); Carotid Artery Stenting (CAS); Plaque diagnosis

Introduction

The benefit of surgical intervention for severe carotid stenosis has been confirmed by randomized clinical trials (RCT) [1-3]. Although there are now two surgical therapeutic methods, carotid endarterectomy (CEA) and carotid artery stenting (CAS), indications for CEA and CAS for cervical carotid stenosis have not been fully established. The Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy (SAPPHIRE) trial reported that the stroke-preventing effect was not significantly different between CEA and CAS in high-risk patients [4]. However, to achieve better clinical results, we have to select CEA or CAS considering not only the patient's condition, but also the characteristics of carotid stenosis and the plaque. This paper suggests an appropriate treatment strategy, especially for high-risk patients, based on our clinical experience of CAS and CEA.

Our Experience

Indications of CEA and CAS

In our clinic, CEA has been considered the first choice of surgical treatment for carotid stenosis patients. CAS was selected for patients with a contralateral ICA lesion, or a distal ICA lesion, or a cervical lesion higher than the C2 vertebral level. CAS has also been selected for patients with medical risk factors such as coronary heart disease. For the treatment of bilateral carotid lesions, milder stenosis was first treated by CAS, and severe stenosis of the contralateral side was then treated by CEA [5]. A balloon occlusion test (BOT) of ICA was performed for selected cases before surgical intervention. When BOT was not tolerable, the carotid lesion was treated by CAS.

From January 2001 to December 2009, we treated cervical carotid stenosis surgically in 171 lesions by CEA and 251 lesions by CAS. The average age of the patients was 69.5 in CEA and 71.0 in CAS. The symptomatic stenosis rate was 68% and the average stenotic rate was 83% in CEA, and these were 62 and 65%, respectively, in CAS [6].

Plaque diagnosis

We preoperatively examined the characteristics of carotid plaque using carotid ultrasonography (US) and/or BB-MRI [7].

Using carotid US, the carotid arteries were examined bilaterally at the levels of the common carotid artery, carotid bifurcation, and internal carotid arteries from transverse and longitudinal orientations. The plaque echogenicity was qualitatively assessed as being, on average, either low, intermediate, or high.

At the same time, we performed carotid artery BB-MRI. The MR signal intensity of the carotid plaque in the area with the highest rate of stenosis was classified into low or high compared with the intensity of the ipsilateral sternocleidomastoid muscle.

The diagnostic rate of soft plaque was 79% on carotid US, and 93% on BB-MRI.

Surgical procedure

CEA was performed under general anesthesia with intra-operative monitors of INVOS (SaO2). An intra-operative carotid arterial shunt was used during cross-clamping, but only when temporary closing of the ICA induced a decrease of more than 10% of the SaO2 value.

CAS was performed under local anesthesia. Pre-dilatation was conducted after distal protection was inserted in the internal carotid artery, and then a stent was placed.

Citation: Tsukahara T. Surgical Treatment of Carotid Arterial Stenosis. Austin Neurosurg Open Access. 2014;1(3): 1014.

Surgical results

Stenosis of the carotid arteries was resolved in all cases after CEA or CAS. The surgical mortality rate with CEA and CAS was 0.6% (1/171) and 0.4% (1/251), respectively. The surgical morbidity rate with ischemic stroke of CEA and CAS was 2.9% (5/171) and 2.4% (6/251), respectively. One patient with untreated coronary heart disease suffered acute myocardial infarction after CAS. Surgical morbidity was not high in patients with medical risk factors [5,6].

Discussion

In Japan, the number of surgical interventions for carotid stenosis has increased by more than three or four times over the last twenty years in proportion to the increased number of patients with carotid stenosis. The Japanese Neurosurgical Society estimated that the number of surgical interventions for carotid stenosis performed throughout Japan was 4,246 cases, including 2,395 cases of CEA and 1,851 cases of CAS in 2003, and 7,445 cases, including 2,839 cases of CEA and 4,606 cases of CAS in 2007, respectively. Twenty years ago, less than 2,000 patients received surgical treatment for carotid stenosis, namely CEA. These changes in the situation can be explained by the fact that the development of endovascular treatment has overlapped the period of increasing carotid stenotic lesions in Japan, and CAS has been widely accepted by the introduction of self-expandable stents and distal embolization blocking systems over the last ten years. On the other hand, the Japanese Guidelines for the Management of Stroke 2004 and 2009 favored CEA over CAS for the treatment of symptomatic severe carotid stenosis. Thus, there is still some controversy regarding the indication for CEA or CAS for cervical carotid stenosis.

The SAPPHIRE trial was the first completed controlled, prospective randomized trial in which CEA was compared with the state-of-the-art CAS with cerebral protection [4]. The SAPPHIRE trial only enrolled patients who were considered at high risk for CEA, as follows: octogenerian, carotid reoperation, cervical radiation, contralateral carotid occlusion, severe tandem lesion, high cervical lesion (at least C2), lesion below the clavicle, and contralateral laryngeal palsy.

The SAPPHIRE trial reported that the perioperative risks of stroke (CAS, 3.1%; CEA, 3.3%) and mortality (CAS, 0.6%; CEA 2.0%) were similar; however, more patients suffered from postoperative myocardial infarction (MI) in the CEA group than in the CAS group.

A recent international RCT comparing CAS with CEA in patients with symptomatic carotid stenosis reported that the incidence of stroke, death, or procedural myocardial infarction was 8.5% in the CAS group compared with 5.2% in the CEA group [8]. The risks of any stroke and all-cause death were higher in the CAS group than in the CEA group. Another recent international RCT also reported the superior stroke-preventing effect of CEA over CAS [9].

Regarding the high medical risk, we chose CAS for patients with untreated coronary disease in our series of treatments. After the coronary disease was treated and stable, CEA did not induce MI in the perioperative period. Other high medical risks did not affect the clinical results [5,6]. Regarding octogenarians, the age of our patients was not different between the groups of CEA and CAS. CEA can be performed safely for aged patients if they do not have other medical risk factors [6].

As for patients with carotid reoperation and cervical radiation, CAS is the first choice since plaque in these patients sometimes adheres tightly to the medial layer, so it may be difficult to construct a smooth intraluminal wall with CEA.

We chose CAS for specific subgroups of patients such as those with a distal ICA lesion and a higher-level lesion, for whom the beneficial effect of CEA is not apparent because of the complication rate. The mean cervical level of the lesion in Japanese patients is C3 or C4, and a number of patients have the lesion at the C2 vertebral level, which is at least one vertebral level higher than the lesions of European patients [10]. This situation sometimes complicates the operative procedure of CEA and canses more complications of lower cranial nerve palsy. Clinical outcomes of the patients with bilateral ICA lesions were not poorer when they received a combination treatment using CEA and CAS; milder stenosis was first treated by CAS, and then severe stenosis of the contralateral side was treated by CEA [5]

The SAPPHIRE trial and other RCTs did not evaluate the character of the plaque or sclerotic lesion of the aorta and common carotid arteries, which have to be considered to achieve better clinical results [1,4,8].

Major ischemic complications of CEA are: 1) embolic stroke in the perioperative stage, and 2) hemodynamic stroke during occlusion of the carotid arteries. The most important factor to prevent embolic stroke may be the surgical CEA procedure. Although it is necessary to detect the precise dissecting layer and not to leave any plaque at the distal end of ICA, this procedure is sometimes complicated and is not easy, especially when the lesion is located at a high cervical level [10]. We used an internal shunt in selected cases to prevent hemodynamic stroke. Since it sometimes increases the risk of embolic stroke to insert a shunt in a distal ICA region, an internal shunt is used in selected cases after examining the cerebral blood flow during closure of the carotid arteries.

A major complication of CAS is embolic stroke caused by dilatation of the stenotic lesion and plaque. Although the safety and durability of CAS have markedly improved, it is still not suitable for the treatment of soft plaque, eccentric or tortuous lesions, or a narrow residual lumen, as a major complication of CAS is embolic stroke caused by dilatation of the stenotic lesion and plaque. Since the recent developments of MRI and Doppler echography have enabled us to detect the characteristics of carotid plaque, we should select CAS or CEA according to the plaque characteristics. Other major complications of CAS could be embolic complications during the cathetarization of eccentric and tortuous sclerotic arteries. We also encountered mortality as a result of catheterization complications, such as blue toe syndrome [6]. When comparing CAS to CEA, the risk of any neurological event is higher, particularly during catheterization and ballooning, despite the use of cerebral protection devices [11]. We should therefore select CEA for severe carotid stenosis and tortuous lesions after studying the aortic arteries by 3DCTA or DSA angiography.

In conclusion, carotid stenotic lesions can be treated with comparably low morbidity and mortality rates using CEA or/and

CAS, even with high medical risks or bilateral carotid stenosis, when appropriate surgical methods are selected considering the characteristics of the carotid plaque and other sclerotic lesions of each patient.

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Citation: Tsukahara T. Surgical Treatment of Carotid Arterial Stenosis. Austin Neurosurg Open Access. 2014;1(3): 1014.