Transbrachial Angioplasty and Stenting without Crossing the Aortic Arch for Right Carotid Artery Stenosis Patients with Complex Aortic Plaques

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Objective: A major risk associated with carotid artery stenting (CAS) is embolic event caused by disturbance of plaque in the aortic arch. To avoid it, we developed a novel and simple technique of transbrachial carotid angioplasty and stenting for right carotid stenosis patients without crossing the aortic arch.

Case Presentations: The patient with complex aortic plaque (CAP) was selected. A 6F guiding sheath was inserted via the right brachial artery. A steam-shaped 6F JB2 diagnostic catheter with an acute “J”-shaped distal tip was used as the inner catheter. The JB2 catheter was advanced into the innominate artery. Under roadmap guidance, JB2 was pulled and cannulated in a common carotid artery (CCA), and a 0.035-inch guide wire was advanced to the distal CCA without insertion into the external carotid artery. JB2 and guiding sheath were advanced to the distal CCA. After JB2 removal, the usual carotid intervention was performed. We applied this method to six patients. For all patients, technical success was achieved. No patient experienced a symptomatic stroke or cholesterol embolism after the procedure.

Conclusion: Our novel and simple technique was safe and successful. This technique might prevent embolic stroke and dislodgement of cholesterol from atherosclerotic aortic arch plaques during neurointervention.

Keywords ▶ carotid artery, carotid stenosis, aortic arch, transbrachial

Introduction

Carotid angioplasty and stenting (CAS) is the standard modality for patients with severe carotid artery stenosis and at high risk for carotid endarterectomy. However, one of the drawbacks of CAS is the potential risk of embolization from aortic atheromatous plaque. Cholesterol crystal embolism (CCE) and contralateral brain embolization can be caused by catheter manipulation within the arch.1,2) Complex aortic plaques (CAP) are easily disrupted by mechanical contact during the procedure and induce embolization of cholesterol crystals.3) CCE causes a systemic inflammatory response that leads to multi-organ dysfunction. Effective therapy has not yet been established, and mortality from CCE is still high.4,5) To prevent embolic complication causing aortic plaques, access through aorta should be avoided during carotid angioplasty and stenting. Several authors have reported carotid artery stenting (CAS) without crossing the aorta.6,7) They have described the use of transbrachial or transradial access, guiding sheath exchange over the long wire using a pigtail or internal mammary artery (IMA) type diagnostic catheter.6,7) These techniques require insertion of guide wire into external carotid artery6,7) and may be inappropriate for patients with common carotid artery (CCA) stenosis. To overcome these drawbacks, we developed a novel and simple technique of carotid angioplasty and stenting without crossing the aortic arch, guide wire insertion into external carotid artery, and catheter exchange.
Case Presentations

A representative case

The patient was a 72-year-old man who had symptomatic right internal carotid artery stenosis. Preoperative 3D CTA showed CAP defined as aortic atheroma with a thickness of 4 mm or more⁸ (Fig. 1A). The patient received two antiplatelet agents: clopidogrel (75 mg) and cilostazol (200 mg) for 2 weeks before the procedure. Carotid intervention was performed under local anesthesia. A 6F guiding sheath (FUBUKI 90 cm, ASAHI INTECC CO., LTD., Nagoya, Japan) was inserted via the right brachial artery to the right subclavian artery. Systemic heparinization was administered following insertion of the sheath, and an activated clotting time of 300 s was maintained during the procedure. A 6F diagnostic catheter (JB2 125 cm; Medikit Co., Ltd, Tokyo, Japan) was used as the inner catheter of the 6F guiding sheath. We bent the distal tip of JB2 into an acute “J”-shape by steaming it for 40 s (Fig. 2A and 2B). The JB2 catheter was advanced into the innominate artery. Under roadmap guidance, the JB2 was pulled and cannulated in a CCA and a 0.035-inch guide wire (Radifocus 150 cm; Terumo Corporation, Tokyo, Japan) was advanced to the distal CCA without insertion into the external carotid artery (Fig. 1B and 1C). An inner catheter and a guiding sheath were advanced to the distal CCA (Fig. 1D and 1E). Under roadmap guidance, the stenotic lesion was traversed with a Filter Wire EZ Embolic Protection System (Boston Scientific, Natick, MA, USA) that was navigated distal to the stenotic lesion. Pre-stenting balloon dilatation was subsequently applied to the stenotic lesions after embolic protection device (EPD) placement, with a 4.5 mm × 30 mm angioplasty balloon. Carotid Wallstent (Boston Scientific) was then deployed. Angiographic views of the head and neck were obtained at the onset of the procedure and after successful stent placement. We removed a guiding sheath and achieved hemostasis by manual compression 4 h after the procedure.

We applied this method to six patients. All the patients were given a clinical examination that including a neurological evaluation, MRI, including diffusion-weighted imaging (DWI), both before and 24 h following the procedure. Preoperatively, all the patients were evaluated by 3D CTA to detect CAP. According to previous report,⁸
Discussion

In this report, transbrachial access was achieved in patients with carotid artery stenosis without crossing the aortic arch, insertion of a guide wire into the external carotid artery, and catheter exchange. Symptomatic stroke or CCE did not occur after the procedure. Furthermore, no patients had any high-intensity areas in the contralateral brain on DWI-MRI after the procedure. CCE causes a systemic inflammatory response that leads to multi-organ dysfunction. Effective therapy has not yet been established, and mortality from CCE is still high.\(^4,5\) Incidence rate of CCE after CAS is unclear. Intervention-associated CCE with renal failure has been reported to occur in 0.9% of 1786 Japanese patients who underwent coronary angiography.\(^4\)

There are very few previous reports of the rate of CCE according to the approach route: the brachial or femoral artery. To our knowledge, there is only one report describing successful CAS via the right brachial artery in a patient with CCE from CAP after previous percutaneous intervention.\(^9\) The authors emphasized the use of the brachial approach to avoid vessel plaque.\(^9\)

It has been reported that the rate of new MRI cerebral lesions after is higher in CAS than in CEA.\(^10\) In a substudy of the International Carotid Stenting Study (ICSS), new MRI cerebral lesions were found in 50% of patients after CAS compared with 17% after CEA.\(^10\) Transcranial Doppler studies have demonstrated that embolic events can occur during intravascular instrumentation of the aortic arch and the supra-aortic vessels.\(^11\) Therefore, crossing the aortic arch is one of the drawbacks of the CAS procedure compared with CEA. Previous reports have described the use of transbrachial or transradial access, guiding sheath exchange over the long wire using a Simmons type diagnostic catheter,\(^12\) and direct cannulation into the CCA using a modified Simmons type guiding sheath\(^13\) during CAS. These conventional techniques of transbrachial and transradial access require catheter manipulation in the aortic arch, and embolism may occur with catheter manipulation causing disruption of CAP.

CAS using the transcervical approach has been reported as a technique to avoid catheter manipulations in the aortic arch. It has also been reported that the rate of high-intensity areas on DWI-MRI after CAS using the transcervical approach was significantly lower than with transfemoral approach.\(^10\) In a meta-analysis, new DWI–MRI lesions after CAS with transcervical access were seen in 14.4% of procedures.\(^14\) Additionally, the usefulness of the transcervical

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we defined that CAP was at least one aortic atheroma with a thickness of 4 mm or more. All the patients had no atheromatous plaque in the right subclavian and brachiocephalic artery. We assessed clinical and procedural outcomes including the association of technical successes and the common carotid artery branching angle (CCBA) and working angle of guiding sheath manipulation obtained from preoperative CTA (Fig. 3).

CCBA were 18°– 65° (mean: 51°). For all patients, technical success was achieved. None of the patients had a symptomatic stroke or cholesterol embolism after the procedure. DWI obtained 24 h after the procedure revealed a high-intensity area in two patients who had a small high-intensity area without symptoms in the ipsilateral cerebral hemisphere on DWI-MRI after the procedure. These patients had an unstable carotid plaque identified as high-intensity area on preoperative time of flight (TOF)-MRA. The other four patients had no high-intensity plaques on TOF-MRA. No nerve palsy or puncture site hematomas were associated with the transbrachial access in any patient.

A summary of the patients is shown in Table 1.

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**Figure 3** The CCBA obtained from preoperative CTA. CCBA: common carotid artery branching angle
approach in patients who have unfavorable aortic arch anatomy has been described. In other studies, comparing transcervical and transfemoral CAS, no contralateral hemispheric infarcts on DWI-MRI were found in the transcervical CAS group, unlike in the transfemoral CAS group. However, transcervical CAS may cause major complications because CCA is close to significant anatomical structures. Thus, transcervical CAS is more invasive than transfemoral, transbrachial, or transradial access. In this study, no infarcts in the contralateral hemisphere on DWI-MRI were found. Therefore, our technique has the possibility of prevention of embolic stroke and cholesterol embolism derived from plaques in the aortic arch. However, our technique may cause embolism in the vertebrobasilar circulation via right vertebral artery. According to the manufacturer, the FUBUKI guiding sheath was designed with a thin, soft distal tip with good flexibility. In our procedure, guide wire insertion into the external carotid artery was not required because of the softness of the guiding sheath. Our technique can also be used in patients with CCA stenosis and in-stent restenosis because guide wire insertion into the external carotid artery was not required. Several authors have reported CAS without crossing the aorta. These techniques require insertion of guide wire into external carotid artery and catheter exchange using long wire. These techniques may be inappropriate for patients with CCA stenosis. Our technique is novel and simpler than these techniques. Using FUBUKI guiding sheath and pig tail catheter as inner catheter without crossing the aortic arch may perform. However, our technique is more useful than this technique because catheter can be reshaped if it is inappropriate shape.

Some limitations of this technique should be addressed. First, this technique is not achievable in patients with stenosis of the right subclavian artery, CCA ostium, or left-sided lesions without a bovine arch. Second, we have no data of transradial access because we performed only transbrachial access in this study. However, the major drawbacks of transbrachial access are puncture site complications such as pseudoaneurysm of brachial artery and median nerve palsy. On the contrary, catheter entrapment due to severe radial artery spasm may occur during transradial CAS. It has been reported that a ratio of radial artery inner diameter to sheath outer diameter <1 is the predictor of radial artery spasm. In cases with enough inner diameter of radial artery and without tortuous radial artery, transradial access can be performed. Third, our technique may be unsuitable for using balloon guide catheter and limited for distal protection. To demonstrate the efficacy of our technique, further studies comparing with the other approach route are needed.

## Conclusion

This novel technique of carotid angioplasty and stenting without crossing the aortic arch was safe and feasible for accessing carotid stenosis. Further studies are required to confirm the efficacy of this technique because of the small study population. This technique might prevent embolic stroke and cholesterol caused by dislodgement of atherosclerotic plaques in aortic arch plaques during neurointervention.

## Disclosure Statement

All authors have no conflicts of interest.

## References


