

Case
Report

First Transcatheter Aortic Valve Implantation via Carotid Artery Performed in Japan

Yusuke Misumi, MD, Toru Kuratani, MD, PhD, Koichi Maeda, MD, Koichi Toda, MD, PhD, Shigeru Miyagawa, MD, PhD, Takayoshi Ueno, MD, PhD, and Yoshiki Sawa, MD, PhD

Transcatheter aortic valve implantation (TAVI) through a peripheral arterial access is often complicated by concomitant arteriopathy. We describe here the first successful case of TAVI through the carotid artery in Japan. The patient was an 83-year-old woman with severe aortic stenosis (AS). Preoperative computed tomography (CT) revealed a shaggy distal aortic arch and left subclavian artery ostium, along with severely calcified bilateral iliofemoral arteries. Trans-apical and direct aortic approaches were abandoned because of frailty. Following the thorough cerebrovascular assessment, the left common carotid artery was selected for arterial access and a CoreValve transcatheter aortic valve was successfully implanted without neurologic complications.

Keywords: aortic valve stenosis, transcatheter aortic valve implantation, trans-carotid arterial access

Introduction

Transcatheter aortic valve implantation (TAVI) is a minimally invasive alternative treatment with good clinical outcomes reported for high-surgical risk patients with severe aortic stenosis (AS).^{1–5} Indications have been gradually expanding from high to intermediate surgical risk patients though a matter of concern remains choice of arterial access. This is the first report in Japan of successful performance of TAVI through the left carotid artery, performed for a patient with severe frailty, depressed cardiac function, severe arteriopathy in the iliofemoral and subclavian arteries, and a shaggy descending aorta with no perioperative complications.

Department of Cardiovascular Surgery, Osaka University Graduate School of Medicine, Suita, Osaka, Japan

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Corresponding author: Yoshiki Sawa, MD, PhD. Department of Cardiovascular Surgery, Osaka University Graduate School of Medicine, 2-2 Yamadaoka, Suita, Osaka 565-0871, Japan
Email: sawa-p@surg1.med.osaka-u.ac.jp



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Case Presentation

The patient was an 83-year-old woman who was referred with decompensated congestive heart failure due to severe AS. On admission, shortness of breath at rest (New York Heart Association [NYHA] Functional Classification IV) and severe frailty (Rockwood's Clinical Frailty Scale 7) were noted. Blood test results revealed significantly elevated serum brain natriuretic peptide (2973 pg/mL). Echocardiography confirmed severe AS with a peak transvalvular velocity of 3.5 m/s, peak/mean transvalvular pressure gradient of 49/26 mmHg, aortic valve area (AVA) of 0.59 cm², and low LV ejection fraction of 37% on inotropic support (dobutamine, 5 µg/kg/min), with generalized severe hypokinesis and pulmonary hypertension. Severe mitral regurgitation (MR) was also detected although MR grade was decreased to mild in dobutamine stress echocardiography findings.

After considering the high logistic euroSCORE and STS values of 76.4% and 12.9%, respectively, we decided to perform TAVI. For vascular access, the femoral, iliac, and subclavian arteries were not suitable because of an atherosclerotic distal aortic arch and left subclavian artery ostium (**Fig. 1**), as well as narrow and severely calcified bilateral iliofemoral arteries.



Fig. 1 Multi-detector CT findings of atherosclerotic distal aortic arch and left subclavian artery ostium. CT: computed tomography

Furthermore, because of severe frailty and low LV function, we also abandoned trans-apical and trans-aortic approaches, as those require a thoracotomy or sternotomy. Meanwhile, the left common carotid artery had a diameter of 6.4 mm, and no stenotic or calcified lesions. Doppler findings of the carotid and vertebral arteries also showed no significant disease (**Fig. 2A**), whereas cerebral magnetic resonance angiography (MRA) revealed a patent and functional circle of Willis (**Fig. 2B**). Following confirmation of the procedural risk of brain ischemia in consultation with the cerebrovascular team, a left common carotid artery approach was finally selected. Informed consent from the patient and her family, as well as the approval of the procedure from the Institutional Review Board were obtained.

The procedure was performed in a hybrid operating room under general anesthesia. Cerebral oximetry (near infra-red spectrometry [NIRS]) monitoring was utilized to assess cerebral perfusion during the procedure (INVOS 5100C, Medtronic, Minneapolis, MN, USA). First, the left carotid artery was exposed via a 3-cm skin incision, then a 3-minute cross-clamping test of the left carotid artery showed no significant signs of cerebral ischemia (NIRS score 18% below baseline). An 18-Fr DrySeal introducer sheath (W.L. Gore & Associates, Newark, DE, USA) was placed into the ascending aorta via the left carotid artery and a 26-mm CoreValve transcatheter aortic valve (Medtronic, Minneapolis, MN, USA)

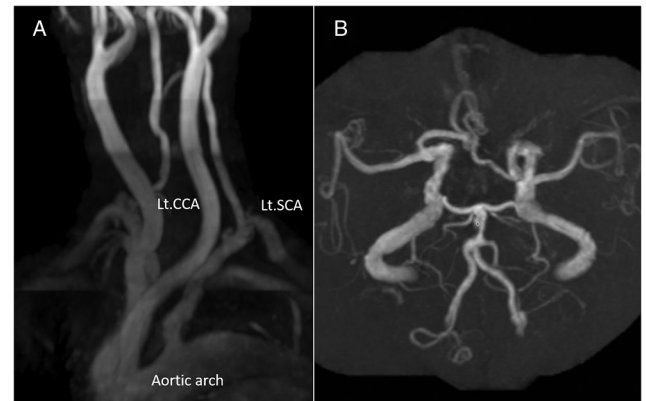


Fig. 2 MRA showed (A) left carotid artery without significant arteriopathy and (B) a patent and functional circle of Willis. Lt.CCA: left carotid artery; Lt.SCA: left subclavian artery; MRA: magnetic resonance angiography

was successfully implanted. After the procedure, the 18-Fr sheath was immediately replaced with a 12-Fr Flexor Check-Flo sheath (Cook Medical, Bloomington, IN, USA) to preserve cerebral perfusion. Total time of the 18-Fr sheath insertion was 20 minutes, with the lowest NIRS score 38% below the baseline. The post-operative course was good without any neurologic event. The patient was weaned from inotropes and symptoms improved from NYHA class IV to II. Post-operative echocardiography showed improvement of the mean transvalvular gradient and AVA to 7 mmHg and 1.44 cm², respectively, and no paravalvular leakage. Thereafter, she was referred to the referring hospital for further rehabilitation.

Discussion

Thanks to improvements in transcatheter tissue valves and reduced crimp profile, an increasing number of patients are eligible to undergo a trans-femoral approach. However, that is occasionally complicated by iliofemoral arteriopathy, such as calcification, atherosclerotic change, and severe tortuosity. Génèreux et al. reported that major vascular complications including vascular dissection, perforation, and access site hematoma were related to higher mortality.⁶ In a recent study by Shijo et al.,⁷ atherosclerotic change of the aorta was also a risk factor for vascular embolic complications to be considered when performing transcatheter procedures.

The present patient had severe aortopathy in the iliofemoral and subclavian arteries, and descending aorta, thus approaches via the femoral and subclavian arteries were abandoned. Trans-apical and trans-ascending

aortic approaches are not recommended for frail patients because of concomitant thoracotomy or sternotomy while Ribeiro *et al.* reported that a trans-apical approach may lead to significantly greater myocardial injury as compared with others.⁸⁾ Our patient had depressed cardiac function and severe frailty; thus, the carotid artery emerged as the last possible arterial access option.

Recently, the feasibility and safety of trans-carotid arterial access have been demonstrated in limited patients.^{9–11)} In cases reported by Modine *et al.* because of concern regarding impaired blood perfusion from the operating side of the carotid artery during insertion of the introducing sheath, carotid, vertebral, and other cerebral vasculatures including complete communication of the circle of Willis were confirmed using color Doppler and cerebral MRA findings by a multidisciplinary team that included both cardiovascular and cerebrovascular physicians.¹⁰⁾ Intraoperatively, monitoring of brain oximetry with NIRS can be utilized. Regarding the indication for placing the shunt, Mille *et al.* report that the reference value is the lowest NIRS score detected in the first 2 minutes after clamping the carotid artery, the required time for auto regulation. They estimated that a cross-clamping test of the carotid artery showing more than a 20% decrease in NIRS score from the baseline might be prognostic for procedural risk of brain ischemia.¹²⁾ The present patient passed the preprocedural cross-clamping test and TAVI was successfully performed without any neurologic complications.

Nowadays, Evolut R (Medtronic, Minneapolis, MN, USA) was already reimbursed in Japan. InLine sheath of Evolut R has lower profile compared to CoreValve delivery system. We may expand the options of peripheral access when such lower profile devices for TAVI will be on the horizon.

Conclusion

In summary, this is the first report in Japan of successful TAVI via the carotid artery for a severely frail patient with depressed cardiac function and severe aortopathy in the iliofemoral and subclavian arteries, and descending aorta. A trans-carotid approach may be useful as arterial access in patients for whom another peripheral arterial access modality is difficult.

Disclosure Statement

None.

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