Safety and Feasibility of Carotid Artery Stenting with Dual-Echo Technique to Minimize Iodinated Contrast Dose

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Background: The aim of this study was to evaluate the safety and feasibility of carotid artery stenting (CAS) employing dual-ultrasound technique and administering a minimal contrast agent in patients with renal insufficiency. *Methods:* Between September 2009 and July 2013, 63 consecutive patients underwent CAS at our institution: dual-echo carotid artery stenting (DECAS) in 7 patients with renal insufficiency and standard carotid artery stenting (STCAS) in the remaining 56 patients. Periprocedural adverse events and outcomes were compared between the 2 groups. *Results:* Technical success was achieved in all cases. The 3 procedure-related complications were 1 case of transient hemiparesis in the DECAS group and 1 transient and 1 permanent case of hemiparesis in the STCAS group. The rate of positive diffusion–weighted-imaging lesions did not differ significantly between the 2 groups (28.6% versus 12.5%, $P = .26$). A significantly smaller volume of contrast was used in DECAS (15 versus 163 mL, $P < .01$). The change in creatinine level remained stable after CAS and did not differ between the 2 groups (.02 versus .03 mg/dL, $P = .96$). *Conclusions:* DECAS is safe and feasible for patients with pre-existing renal insufficiency and can provide an alternative for patients with carotid stenosis and renal insufficiency. **Key Words:** Carotid artery stenting—chronic kidney disease—ultrasound—IVUS.

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Received August 7, 2017; revision received August 15, 2017; accepted August 20, 2017.

Grant support: This study was supported by the Clinical Research Promotion Foundation.

Author contributions: M.O.: acquisition, analysis, and interpretation of data for the work; T.H.: substantial contributions to the conception or design of the work; K.F.: data collection and analysis; T.O.: drafting or revising the work critically for important intellectual content; T.Y.: data collection and analysis; T.I.: final approval of the version to be published.

Data sharing: Clinical data were collected from the electrical charts at our hospitals. No data from other studies were used in this study.

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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2017.08.030

Introduction

In the Carotid Revascularization Endarterectomy versus Stenting Trial (CREST),[1,2] both carotid artery stenting (CAS) and carotid endarterectomy achieved excellent safety profiles when performed by experienced and well-trained operators. This reflects continuing improvement in CAS. In CREST, each revascularization technique attained the target stroke and death rates recommended by the American Heart Association, thus justifying their use for stroke prevention in both symptomatic and asymptomatic patients. As a result, the U.S. Food and Drug Administration has approved CAS as an alternative to carotid endarterectomy for standard-risk as well as high-risk patients.

However, the number of patients with diabetes mellitus or pre-existing renal insufficiency is increasing. Intravenous injection of contrast material, which is essentially required for CAS, may result in acute renal insufficiency in 8%-31% of diabetic patients who receive it.[3-6] A recent study documents that CAS for patients with

chronic kidney disease is associated with a 3-fold higher adverse event rate.[7] In this study, postprocedural acute kidney injury is strongly associated with unfavorable mortality. The use of a contrast agent must therefore be minimized in patients with chronic kidney disease to prevent acute kidney injury.

Duplex arterial mapping as a sole preoperative diagnostic modality is an acceptable alternative to standard contrast-enhanced arteriographic studies before carotid surgery.[8] Modern duplex scanners provide excellent images and reliable hemodynamic parameters of the carotid arteries and have increasingly been used alone to evaluate the exact location, degree, and extent of a carotid lesion in the neck. Intravascular ultrasound (IVUS) has also been proven to be a good pretreatment diagnostic tool for the evaluation of plaque and post-CAS identification of defects without the use of a contrast agent. Bandyk and Armstrong reported the feasibility of IVUS during CAS.[9] IVUS gives us more accurate information on devise sizing and reduces the amount of contrast agent at usual procedures.

We investigated the safety and feasibility of dual ultrasonography, that is, both percutaneous ultrasonography and IVUS, for CAS in patients with renal insufficiency.

Methods

Sixty-three consecutive patients underwent CAS at Fukuoka University and Japanese Red Cross Fukuoka Hospital from September 2009 to July 2013 and were included in the present study. Indication for dual-echo carotid artery stenting (DECAS) was either an estimated glomerular filtration rate lower than 30 mL/minute[10] or a serum creatinine level higher than 2 mg/dL.

Perioperative Evaluation

Cerebral angiography was performed in all patients. For patients with renal insufficiency, angiography of the carotid stenosis was performed once via transfemoral and transradial approaches. Then difficulties of accessibility such as severe tortuosity, type III aorta, and bovine arch were evaluated.

B-Mode carotid echogram and black-blood magnetic resonance imaging (MRI) were performed to evaluate the vulnerability of carotid plaque.

Carotid lesions were diagnosed by 3-dimensional digital subtraction angiography (3DDSA) according to the method used in the North American Symptomatic Carotid Endarterectomy Trial. Patients with a symptomatic stenosis above 50% or an asymptomatic stenosis above 80% met our criteria to undergo CAS.[11]

Neurological examinations were carried out in each patient before and immediately after, the day after, and 30 days after CAS. Transient morbidity was defined as any new neurological deficit appearing after CAS that resolved within 30 days after CAS. Thirty-day morbidity was defined as a persistent neurological deficit observed at the 30-day follow-up.

MRI, including diffusion-weighted imaging (DWI), was evaluated immediately to several days after the procedure.

Standard Carotid Artery Stenting (STCAS)

Before each CAS procedure, the patient was premedicated with dual-antiplatelet therapy for least 5 days before treatment.

CAS was performed by an experienced neurointerventional team via a percutaneous transfemoral route. All cases were performed under local anesthesia. The femoral artery was cannulated in a retrograde fashion with a single-entry needle using the Seldinger technique. We usually inserted an 8-Fr, 25-cm-long sheath. Fluoroscopy was used to assist advancement of the .035-inch guidewire into the aortic arch. After the guiding catheter was negotiated into the common carotid artery, 3DDSA was performed using 24 mL of contrast agent. We used 1 of 3 types of distal embolic protective devices in all cases: AngioGuard XP Emboli Capture Guidewire System (Cordis Corporation, Miami Lakes, FL), Neuroform EZ Stent System (Stryker Neurovascular, Fremont, CA), or PercuSurge GuardWire (Medtronic Arterial Vascular Engineering, Santa Rosa, CA). In some cases, flow-reversal protection using PercuSurge and Optimo (Tokai Medical Products, Aichi, Japan) was also performed.[12] After positioning the protective devices, a 2.9-Fr, 20-MHz IVUS catheter (Eagle Eye Gold Catheter; Volcano Therapeutics, Rancho Cordova, CA) was advanced over a .014-inch guidewire and placed in the distal ICA. The device was then gradually withdrawn at a speed of 1.0 mm/s with a motorized pullback system. This method allowed us to evaluate the extent and the composition of the plaque and to determine the appropriate stent size.

Once a protected environment was established, the lesion was predilated with a 3.0-3.5 × 20-mm balloon, if necessary, and a Precise PRO RX (Cordis), Carotid WALLSTENT (Boston Scientific, Marlborough, MA), or Protege RX Carotid Stent (Covidien Ltd., Dublin, Ireland) was then deployed and postdilatation was performed with a 4.5-6.0 × 30-mm balloon. In cases in which the PercuSurge or the flow-reversal system was used, postdilatation was followed by aspiration and filtering of 60 mL of blood through the catheter (or ongoing aspiration until it was free of debris) and then deflation of the protective balloons. IVUS was used to assess for patency and the presence of an in-stent thrombus. Finally, 3DDSA was again performed with 24 mL of contrast agent. Femoral access was routinely used with an Angio-Seal device (St. Jude Medical, St. Paul, MN). After the completion of CAS, heparin was not reversed, leaving its effect to disappear spontaneously.