Available online at www.sciencedirect.com
ScienceDirect
Surgical Neurology 70 (2008) 279–286
SURGICAL NEUROLOGY
www.surgicalneurology-online.com

Carotid Stenosis

Periprocedural hemodynamic instability with carotid angioplasty and stenting

Mahmoud M. Taha, MD[a,*], Naoki Toma, MD, PhD[a], Hiroshi Sakaida, MD, PhD[a], Kotaro Hori, MD, PhD[a], Masayuki Maeda, MD, PhD[b], Fumio Asakura, MD[a], Masashi Fujimoto, MD[a], Satoshi Matsushima, MD, PhD[a], Waro Taki, MD, PhD[a]

[a]*Neurosurgery and* [b]*Neuroradiology Department, Mie University School of Medicine, Mie, Japan*

Received 14 May 2007; accepted 3 July 2007

Abstract

Background: Carotid angioplasty and stenting is used for treatment of carotid stenosis. Stent deployment may induce HDI and thereby cause systemic or neurologic deficits. This study defines characteristics and predictors of HDI with CAS.

Methods: A total of 132 patients who had undergone CAS were evaluated for periprocedural and postprocedural HDI (hypertension, systolic blood pressure >160 mm Hg; hypotension, systolic blood pressure <90 mm Hg; or bradycardia, heart rate <60 beats per minute).

Results: Frequencies of HDI were 6.8% for hypertension, 32.6% for hypotension, and 15.9% for bradycardia. In addition, CAS of the right side ($P < .01$), carotid bulb lesions ($P < .05$), eccentric posterior carotid plaque ($P < .0001$), and general anesthesia ($P < .05$) were associated significantly with postprocedural HDI. Male sex (OR, 3.4; 95% CI, 1.8-67.2; $P < .001$), age of 80 years or older (OR, 0.4; 95%CI, 0.1-1.4; $P = .011$), and plaque ulceration (OR, 0.5; 95% CI, 0.1-9.5; $P = .008$) independently predicted postprocedural hypertension. Male sex (OR, 2.5; 95% CI, 1.3-24.9; $P < .001$), preprocedural major stroke (OR, 0.1; 95% CI, 0.01-0.8; $P = .002$), carotid bulb lesions (OR, 1.6; 95% CI, 1.1-25.9; $P = .024$), and contralateral carotid occlusion (OR, 0.6; 95% CI, 0.2-4.9; $P = .040$) all predicted postprocedural hypotension. Bradycardia was associated with diabetes mellitus (OR, 0.7; 95% CI, 0.3-2.4; $P = .033$), preprocedural TIA (OR, 1.7; 95% CI, 1.4-17.9; $P = .020$), and minor stroke (OR, 1.5; 95% CI, 1-10.9; $P = .037$). In 5 patients, HDI predisposed neurologic or systemic deterioration.

Conclusions: Hemodynamic instability is common with CAS; hypotension and bradycardia are more frequent than hypertension. Some clinical, angiographic, and procedural variables can predict these HD changes.

Keywords: Carotid stenting; Baroreceptors; Hypotension; Acute renal failure; Intracerebral hemorrhage

Abbreviations: ARF, acute renal failure; CAS, carotid angioplasty and stenting; CCA, common carotid artery; CEA, carotid endarterectomy; CI, confidence interval; ECA, external carotid artery; ECG, electrocardiography; HD, hemodynamic; HDI, hemodynamic instability; ICA, internal carotid artery; MRSS, Modified Rankin Stroke Scale; NASCET, North American Symptomatic Carotid Endarterectomy Trial; OR, odds ratio; PTA, percutaneous angioplasty; TIA, transient ischemic attack.

* Corresponding author. Tel.: +81 59 232 1111; fax: +81 59 231 5212. Request reprint: Waro Taki, Department of Neurosurgery, Mie University School of Medicine, Mie Prefecture Tsu 514-8507, Japan. Tel.: +81 59 232 1111; fax: +81 59 231 5212.

E-mail addresses: mahmoudlotfy1972@yahoo.co.uk (M.M. Taha), taki@clin.medic.mie-u.ac.jp (W. Taki).

0090-3019/$ – see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.surneu.2007.07.006

1. Introduction

Carotid angioplasty and stenting is evaluated as a minimally invasive therapeutic alternative to CEA to prevent ipsilateral stroke from atherosclerotic carotid arteries [24]. Hemodynamic instability (hypertension, hypotension, or bradycardia) is a well-recognized perioperative surgical complication after endarterectomy. It has been linked to neurologic deficits [5,21]. Conventional repair including removal of atheromatous plaque may stretch the arterial wall, thereby increasing discharge from the adventitial baroreceptors, which may engender HD compromise [5,21]. Newly emerging percutaneous angioplasty and stenting techniques may trigger a baroreceptor reflex through instrumental manipulations at the carotid sinus. Still, a few recently published reports have implied that severe hypotension and bradycardia occur less frequently with improved stent technology and the use of low pressure values during stent dilatation [6,10,17]. This study assessed the frequency and characteristics of HDI with CAS as well as the associated clinical, angiographic, and technical variables that are predictive of instability.

2. Methods

At the neurosurgery departments of Mie University in Japan between 2000 and 2005, 134 patients with carotid stenosis underwent CAS. Of them, 2 patients with incomplete data were excluded. The remaining 132 CAS patients were included in this study. All patients underwent a complete neurologic examination before and after intervention by a vascular neurosurgeon who was not involved in the CAS (SM). All patients received 100 mg of acetylsalicylic acid and 200 mg of ticlopidine or 200 mg of cilostazol at least 7 days before the procedure. During the procedure, the patients received 4000 to 5000 U of heparin intra-arterially during the early procedure with an additional 1000 U/h to maintain their activated clotting time between 250 to 300 seconds. After the procedure, patients were maintained on 200 mg of clopidogrel for 3 months and 100 mg of acetyl salicylic acid indefinitely. In addition, 0.5 mg of atropine sulfate was administered to reduce bradycardia and hypotension induced by baroreceptor stimulation during CAS. A transfemoral approach is the standard for percutaneous stenting; a transbrachial approach was used for 2 patients, whereas direct carotid puncture was used in 5 patients. Endovascular interventions were done in a fasting state with adequate hydration. Regular antihypertensive medications were given early in the morning. Continuous ECG (3 leads) and continuous blood pressure monitoring with an automated cuff attached to a patient's left arm were maintained throughout the procedure and the postoperative period. After stenting, the patients were transferred to the neurointensive care unit for continuous 24-hour observation. Postprocedural hypotension was treated with intravenous fluids and dopamine infusion if refractory to maintain adequate mean arterial pressure, whereas hypertensive patients were treated with intravenous nicardipine. A second atropine dose was administered if a patient developed bradycardia.

Types of stents that were used included Smart stent (Cordis, Johnson & Johnson, Warren, Ind) in 72 patients, Precise (Cordis) in 19 patients, Wallstent (Target Therapeutic, Boston Scientific Corp, Natick, Mass) in 14 patients, Protégé (ev3 Inc, Irvine, Calif) in 10 patients, Acculink (Guidant Corp, Indianapolis, Ind) in 8 patients, Palmaz (Cordis) in 8 patients, and Aurora (Medtronic Inc, Santa Rosa, Calif) in 1 patient. Cerebral protection devices were used in 130 of 133 patients, 17 patients were treated using the Parodi Anti-embolic Systems (ArteriA Medical Science, San Francisco, Calif), 36 patients were treated using PercuSurge GuardWire (Medtronic AVF, Santa Rosa, Calif), 32 patients were treated by simultaneous temporary occlusion of the ICA and ECA using a PercuSurge GuardWire and a Sentry balloon catheter (Boston Scientific Corp), 40 patients were treated using Naviballoon (Kaneka Medics, Osaka, Japan), and 5 patients were treated with the use of a commercially available filter, Mint Catch (Century Medical, Tokyo, Japan). This study was conducted within the guidelines of the research committee of our institution. Informed consent was obtained from patients or their authorized representatives.

3. Data collection

We retrospectively reviewed patient medical reports, operative reports, discharge summaries, and follow-up sheets. Baseline clinical characteristics for each patient included age, sex, risk factors (hypertension, diabetes mellitus, cardiac diseases, smoking, hyperlipidemia, etc), and clinical presentation (Table 1). Furthermore, the causes of carotid stenosis were assessed as potential predictors of HD changes. Angiographic images were reviewed retrospectively for evaluation of carotid plaque characteristics; the degree of stenosis was determined according to the NASCET criteria [16]. Also evaluated were the side of the treated carotid (right or left), carotid plaque ulceration, symmetry (concentric vs eccentric), presence of calcification as well as location of stenosis (whether involving the carotid bulb), and contralateral carotid occlusion (Table 2). Technical variables included the type of stent and protection devices used, the diameter and length of balloons and stents, and the type of anesthesia (general or local) (Table 3). We statistically analyzed clinical, angiographic, and technical factors and examined correlations between them and the occurrence of HDI (Table 4). Definitions of HDI were chosen according to the criteria described by Qureshi et al [19]. Hypertension was defined as any episode of systolic blood pressure of greater than 160 mm Hg; hypotension was inferred if systolic blood pressure was of less than 90 mm Hg, whereas bradycardia was defined as episodes of heart rate of less than 60 beats per minute. Hypotension that recovered with fluid administration, atropine, and inotropics