

● *Clinical Note*

## HEMODYNAMIC EFFECTS OF PROXIMAL SUPRA-AORTIC ARTERY STENOSIS ON ANTERIOR CEREBRAL ARTERY

NICOLÁS LÓPEZ-HERNÁNDEZ,\* ALEJANDRO GARCÍA-ESCRIVÁ,<sup>†</sup> FEDERICO BALLEÑILLA,<sup>†</sup>  
and JOSE IGNACIO GALLEGU-LEON<sup>†</sup>

\*Neurology Department, Hospital General Universitario de Alicante, Alicante, Spain; and <sup>†</sup>Neurology Department, IMED Levante Hospital, Alicante, Spain

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**Abstract**—Alternating flow in the anterior cerebral artery is a rare finding, associated with innominate artery stenosis. We present a series of four patients with this finding on transcranial color coded sonography, under basal conditions. In all of these patients, vascular studies detected an ipsilateral proximal stenosis, three in the innominate artery and, for the first time, one at the left common carotid artery origin. Successful angioplasties with stenting were performed, resulting for the first time in the normalization of orthograde flow in all cases. We conclude that an early systolic hemodynamic compromise in the first segment of the anterior cerebral artery, in the form of alternating flow, is an indirect indicator of ipsilateral proximal stenosis in the supra-aortic arteries, either in the innominate artery or at the origin of the left common carotid artery. (E-mail: [lopez\\_nic@gva.es](mailto:lopez_nic@gva.es)) © 2015 World Federation for Ultrasound in Medicine & Biology.

**Key Words:** Alternating flow direction, Anterior cerebral artery, Innominate artery, Stenosis, Transcranial Doppler, Doppler ultrasound.

### INTRODUCTION

Alternating flow in vertebral arteries (VAs) is a common Doppler ultrasound finding in subclavian steal phenomenon (Sakima et al. 2011). However, this type of finding in a basal cerebral artery is an extremely rare event. In some patients with innominate artery (IA) stenosis, the post-ischemic hyperemia of the upper extremities temporarily elicits this ultrasound finding in some basal arteries (Rautenberg and Hennerici 1988). To our knowledge, under basal conditions, only two cases of alternating flow in the anterior cerebral artery (ACA) have been reported (Brunhölzl and von Reutern 1989; Tan et al. 2002). In both cases, the authors found an IA stenosis, suggesting a possible causal relationship.

We describe a unique series of four patients with alternating flow in the ACA, ipsilateral to a proximal supra-aortic artery stenosis, including the first case involving a proximal left common carotid artery (CCA) stenosis, with restoration of orthograde flow in all cases after angioplasty and stenting.

### METHODS

From all studies done in our neurosonology laboratory between January 2012 and January 2014, transcranial color coded sonography, under basal conditions, revealed alternating wave flow in a basal cerebral artery in four patients. The transcranial ultrasound studies were performed through the temporal window with a 1- to 4-MHz probe (Acuson Antares, Siemens, Erlangen, Germany) with the patient in a supine position, at rest, without any provocation maneuver. All patients were asymptomatic, without symptoms after arm exercise, and had been referred from the outpatient clinic. All patients underwent a complete vascular examination to exclude vascular disorders. Table 1 summarizes the main demographic and vascular characteristics of the four cases.

### RESULTS

Patient 1, with alternating wave flow in the left A1 segment of the ACA, had a severe stenosis at the left CCA origin (Figs. 1 and 2). Patients 2–4 had a severe stenosis of the IA, and the alternating wave flow was detected in the right A1 segment of the ACA (Figs. 1 and 3). In all cases no other alternating flow was

Address correspondence to: Nicolás López-Hernández, Neurology Department, Hospital Universitario de Alicante, C/ Pintor Baeza, 12, 03010, Alicante, Spain. E-mail: [lopez\\_nic@gva.es](mailto:lopez_nic@gva.es)

Table 1. Clinical and vascular findings in four patients with alternating wave flow in the ACA

Patient No./age/sex	Vascular risk factors	Intracranial alternating wave flow	Post-stenotic changes*	Vascular disease	Brain MRI	Stenting	ACA flow after stenting
1/65/M	HL HT Smoker	L-ACA	L-CCA L-ICA L-MCA	L-CCA: near occlusion R-ICA: 50%–69% L-VA: occlusion	Normal	(L-CCA) Successful	Normal
2/55/F	HL	R-ACA, L-V4	R-ICA <sup>†</sup>	IA: >80% L-VA: hypoplastic	Left PICA infarct	(IA) Residual stenosis	Orthograde flow <sup>†</sup>
3/68/F	None	R-ACA, R-V4	R-MCA R-CCA R-ICA	IA: >80%	Right temporal infarct	(IA) Successful	Normal
4/73/F	HL HT AF	R-ACA	R-ICA	IA: >80% R-ICA: 50%–69% L-ICA: 50%–69%	Normal	(IA) Successful	Normal

ACA = anterior cerebral artery; AF = atrial fibrillation; CCA = common carotid artery; HL = hyperlipidemia; HT = hypertension; IA = innominate artery; ICA = internal carotid artery; L = left; MCA = middle cerebral artery; MRI = magnetic resonance imaging; PICA = postero-inferior cerebellar artery; R = right; V4 = fourth segment of vertebral artery; VA = vertebral artery.

\* Post-stenotic changes in ultrasound study (delayed systolic peak and low pulsatility index).

<sup>†</sup> Systolic deceleration.

found in extra- or intracranial carotid branches (see [Supplementary Video](http://dx.doi.org/10.1016/j.ultrasmedbio.2014.12.018), in the online version at <http://dx.doi.org/10.1016/j.ultrasmedbio.2014.12.018>).

In all cases, angioplasty and stenting were performed on the affected arteries because of the observation of [Rautenberg and Hennerici \(1988\)](#) of a close relation between cerebrovascular events and transient hemodynamic changes. The satisfactory restoration of the lumen in cases 1, 3 and 4 was associated with complete normalization of orthograde flow in the cerebral arteries ([Figs. 2 and 3](#)). In patient 2, because of the presence of hard plaque, the angioplasty was only partially successful, with a residual stenosis. In this case, follow-up transcranial color coded sonography revealed a persistent systolic notch, but complete orthodromic flow.

All patients were informed about the procedure and gave consent to angioplasty and stenting.

## DISCUSSION

[Brunhölzl and von Reutern \(1989\)](#), in a series of 20 patients with stenosis of the IA, recorded one case in which an alternating flow pattern in the anterior cerebral artery was also detected. More recently, [Tan et al. \(2002\)](#) reported a similar case and concluded that this intracranial alternating flow could correspond to a remote effect of the stenosis. In our series, the largest published to date, we also observed normalization of this intracranial hemodynamic phenomenon after stenting of the stenoses, providing further evidence supporting this possible

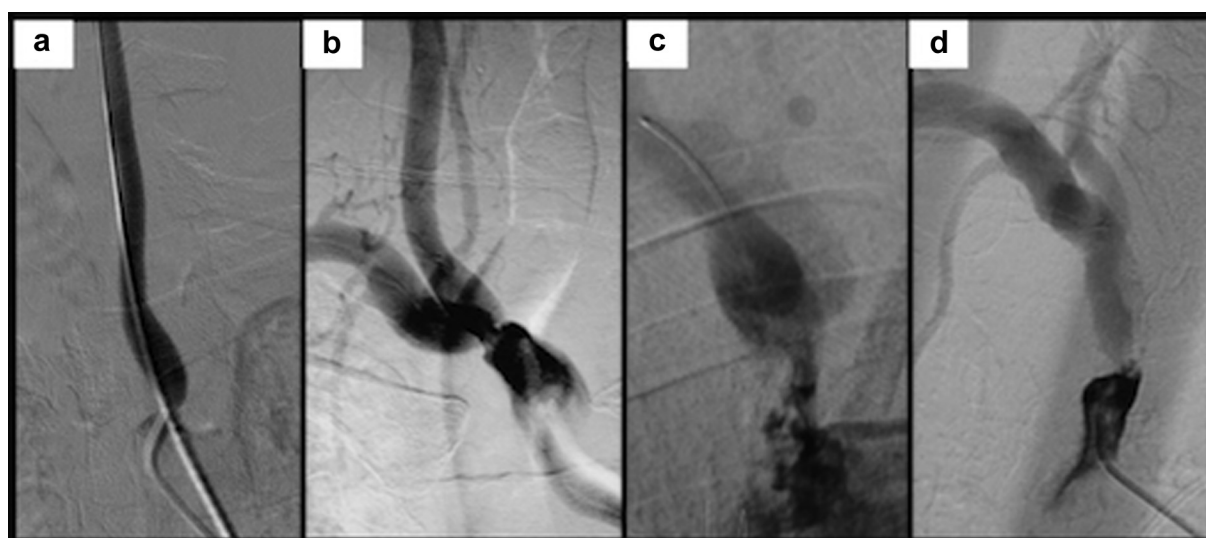


Fig. 1. Digital angiograms revealing (a) a stenosis at the origin of the left common carotid artery in case 1 and (b–d) stenosis of the innominate artery in cases 2–4, respectively.

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