Intravascular Ultrasound and Virtual Histology of Basilar Artery Atherosclerotic Lesion

A Case Report

A. LÓPEZ-RUEDA¹, A. GONZÁLEZ GARCÍA², M. AGUILAR PÉREZ³,
I. GUTIÉRREZ JARRÍN², A. MAYOL DEYÁ²

¹ Interventional Neuroradiology, Hospital Clinic i Provincial; Barcelona, Spain

² Interventional Neuroradiology, Hospitales Universitarios Virgen del Rocío; Seville, Spain

³ Klinik für Neuroradiologie, Katharinenhospital, Klinikum Stuttgart; Stuttgart, Germany

Key words: brain, cerebral, anterior communicating, aneurysm

Summary

To our knowledge, this paper presents the first intravascular ultrasound and virtual histology (IVUS-VH) study in the basilar artery. IVUS-VH serves to characterize and determine the extension of the plaque and we also to check stent placement.

Introduction

Although the composition of intracranial atherosclerotic plaque has been researched using different imaging techniques, endovascular ultrasound remains a technique not regularly employed in interventional neuroradiology. The initial validation for intravascular ultrasound and virtual histology (IVUS-VH) came from an *ex vivo* model utilizing 51 excised and sectioned human left anterior descending coronary arteries¹. This demonstrated the potential of this imaging tool for the analysis of plaque vulnerability. The CAPITAL (Carotid Artery Plaque Virtual histology Evaluation) study² reported a strong correlation between plaque

characterization and subsequent true histological examination of the plaque following endarterectomy. This is the first description, to our knowledge, of IVUS-VH of the basilar artery (BA), with the VH characterization of the atherosclerotic plaque in an intracranial artery.

Case Report

A 57-year-old man with hypertension, alcohol and tobacco abuse, diabetic retinopathy treated with laser therapy, and IIb intermittent claudication, was evaluated for headache, gait instability and vertigo. On physical examination, left homonymous inferior quadrantanopia without paresis or impaired sensation was detected.

Cranial MRI showed acute ischemic lesions in the cerebellum and occipital lobes while MR angiography disclosed severe stenosis in the left vertebrobasilar junction, with BA involvement, and in the right intrapetrous internal carotid artery (Figure 1). The right vertebral artery was hypoplastic.

The use of IVUS-VH was approved by our institutional review board and written informed consent was obtained. The patient was under general anesthesia, with IV heparin (5000 U) having been administered dual antiplatelet therapy for the previous three days (aspirin 125 mg/day and clopidogrel 75 mg/day). The four-vessel cerebral angiography showed a hypoplastic right

Abbreviation key

IVUS = Intravascular Ultrasound

VH = Virtual Histology

BA = Basilar Artery

LVA = Left Vertebral Artery

PICA = Postero Inferior Cerebellar Artery

Figure 1 A) DWI shows acute ischemic lesions in the left occipital lobe. B) MR angiography shows severe stenoses in the left vertebrobasilar junction (arrow) and in the right intrapetrous internal carotid artery.

vertebral artery, severe stenosis at origin of left vertebral artery (LVA) and in the proximal BA. We decided to treat the stenotic lesion since the patient had only one vertebral artery. First, IVUS-VH was performed on the lesion at the origin of the LVA. The atherosclerotic plaque, that caused a stenosis of almost 80%, was an eminently fibrolipidic plaque. A balloon-expanding stent was performed with excellent revascularization. In post-stenting IVUS, the correct placement of the stent was confirmed with good stent apposition on the artery wall.

Then an exchange-length 0.014-inch micro-wire was passed through the basilar stenosis and prior to intervention, IVUS-VH images were obtained using a 2.9F microcatheter (Eagle Eye Gold catheter, Volcano Corporation, Rancho Cordova, CA, USA) with an incorporated 20-MHz phased-array with a 64 piezoelectric transducer. This may result in inferior gray scale IVUS images when compared to the contemporary rotational catheter system. The procedure was carried out with rapid-exchange monorail systems; the IVUS-VH beginning from the distal vessel, at least 10 mm distal to the culprit lesion and progressing in a retrograde direction to the most distal vertebral artery free of disease (Figure 2A). The catheter was pulled back using the motorized pull-back

system at a rate of 0.5 mm/ second. During pullback, continuous grey-scale IVUS was recorded. Radiofrequency data were captured at the top of the R wave using a commercially available system (In.Vision Gold, Volcano Corporation Rancho Cordova, CA, USA). The data were stored on digital video discs. There were no difficulties crossing the stenosis or withdrawing the device over the stenosis. In these B-mode images we detected a 90% stenotic lesion (Figure 2C). Virtual histology analysis was performed for each frame, and the area of each plaque constituent (fibrous, fibro-fatty, calcific, and necrotic core) was determined in an automated fashion using Volcano S5 software (Volcano Corp). The process is time-consuming because adjustments to the borders that delineate the plaque are usually necessary.

The intracranial plaque was studied with IVUS-VH, showing a fibrolipid plaque without necrotic core or calcium (Figure 2D). With IVUS, the length of the plaque was assessed, detecting the origin of the left PICA, which no longer showed pathological intimal thickening. The BA located above the brainstem and surrounded by cerebrospinal fluid (Figure 2B) was observed in IVUS. The stenosis was predilated with a 3×12 mm balloon (Gateway, Boston Scientific, Fremont Co., CA, USA) and a 4×15

Figure 3 A) Post-stenting angiographic control with good results. B) Post-stenting ultrasound study confirms the correct placement and the recovery of the arterial lumen. The stent can be seen in the hyperechoic lines without acoustic shadowing (arrow) located between the lumen and residual plaque.

Wingspan stent (Boston Scientific, Fremont Co., CA, USA) was placed. In the IVUS after stenting (Figure 3) we found a correct stent position, covering the plaque and well-adapted to the vessel wall. The patient awoke from anesthesia without any complications. He was kept on dual antiplatelet therapy for six months.

Discussion

Intravascular ultrasound and virtual histology (IVUS-VH) is a procedure that enables us to study atherosclerotic plaque, characterize it and determine its length and composition. By color coding, VH study shows four plaque components: fibrous (dark green), fibrolipid (yellow/green), necrotic core (red) and calcium (white). No intraplaque hemorrhage can be detected by IVUS-VH. The CAPITAL study² was carried out on extracranial carotid plaque. It offers a quantitative and morphological classification of atherosclerotic plaque, defining six types of plaque and identifying the most vulnerable, i.e. those with a higher risk of embolism. The IVUS-VH procedure started to be used in coronary arteries for plaque characterization and an aid to angioplasty and stenting. It was later used in

carotid arteries for the same purpose. With this procedure we can detect vulnerable plaque and embolic risk areas within each plaque. In our case, the atherosclerotic plaque of the BA was an eccentric fibrolipid plaque, without necrotic core and calcium areas. Such necrotic core and calcium areas, when in contact with the lumen, are defined in the CAPITAL study as vulnerable areas (embolic areas). IVUS is also useful to determine the extent of plaque, and to thus determine the length and diameter of the stent. Microcatheter navigability in the posterior circulation is better than in the anterior circulation because the artery has no bone anchor, unlike the internal carotid artery that is anchored to the petrous bone at the intrapetrous segment. Several cases of IVUS in an intracranial artery have been described in the literature^{3,4}. Takayama et al. are the only ones to use VH. They published a case of angioplasty and stenting with the assistance of IVUS-VH in intracranial vertebral artery stenosis⁵. In this case, the IVUS-VH study was performed after balloon dilatation, its artifact the VH study. The other two cases were aided by IVUS in angioplasty and stenting, without performing VH of the plaque^{3,4}. To our knowledge this is the first IVUS-VH study in the basilar artery.

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Antonio López-Rueda, MD
C/ Costa de la Luz, 76, 4^oC
04009 Almería (Spain)
Tel.: 652245767
Fax: 950149863
E-mail: alrueda81@hotmail.com