Carotid ultrasound in the assessment of atherosclerosis: a guide for residents

Poster No.: C-1240
Congress: ECR 2018
Type: Educational Exhibit
Authors: A. B. Gil Guerra, M. A. Schuller Arteaga, J. Galvan Fernandez, M. Rodriguez Velasco, S. Joral del Hoyo, P. Santos Velasco, R. Petruzzella Lacave, M. E. gomez san martin, M. Brahim Salek; Valladolid/ES

Keywords: Arteries / Aorta, Vascular, Ultrasound-Colour Doppler, Ultrasound, Ultrasound-Spectral Doppler, Diagnostic procedure, Arteriosclerosis, Embolism / Thrombosis

DOI: 10.1594/ecr2018/C-1240

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

• Standardization of the carotid ultrasound protocol.
• Review of the imaging features and hemodynamic related parameters in carotid stenosis.
Background

Ultrasonography is the first examination for screening and diagnosis of extracranial atherosclerotic carotid disease [1, 2].

Its main objective is the detection of a stenosis greater than 70% and the evaluation of plaques as an embolic source [1, 2].

Other indications are:

- Diagnosis of non-atheromatous extracranial carotid disease such as aneurysm, carotid body tumors and dissection [3].
- Pre-surgical study in artheriopatic patients or with high-risk [4].
- Follow-up of carotid disease [4].
Findings and procedure details

A high-frequency linear transducer should be used, with the patient in supine position, the head extended and rotated towards the opposite side to be explored [1, 4].

Using B-mode imaging we perform a transverse sweep from suprACLavicular region to the level of the mandible to locate the carotid bifurcation and identify the areas with greatest affectation. Later, in a longitudinal plane, and using color Doppler-mode we try to identify areas of abnormal blood flow that we further analyze with spectral Doppler [1-4].

B-mode imaging:

Intima-media thickness (IMT): it is measured on the posterior wall of the common carotid artery (CCA) [1]. Fig. 1 on page

The IMT is normal when lower than 1 mm [1]. Above this value, it is associated with higher risk for stroke and myocardial infarction [1, 4].

Plaque: we must document the localization, size and characteristics of the plaque.

Homogeneous plaques have a smooth surface and may be anechoic (type 1) Fig. 2 on page 6 or echogenic (type 4) Fig. 3 on page 6 [3]

Heterogenous plaques (type 2 and 3) are more frequent in symptomatic patients because of their embolic potential [1, 3]. Fig. 4 on page 8, Fig. 5 on page 7.

Types 1 and 2, hypoechoic plaques, are more symptomatic plaques because they are unstable, friable and have greater hemorrhage or lipid content [1, 3].

Color Doppler imaging:

Color doppler mode allows to assess the permeability and identify areas with anomalous flow which associate aliasing and that will be analyzed with spectral doppler[2, 3].

We must adjust the color velocity scale and the gain to avoid artifacts like "aliasing" or "blooming". In a normal carotid examination the color velocity scale is between 30 and 40 cm/s [1].
Also the color doppler allows us to identify ulcerated plaques and a better visualization of hypoechoic plaques [1].

**Doppler spectral imaging:**

Doppler-spectral analysis must be performed in the common carotid artery, internal carotid artery, external carotid artery and vertebral artery, to identify the hemodynamic changes associated with a stenosis.

The doppler angle of incidence must be less than or equal to 60º and the sample volumen box should be in the mid lumen and paralell to the vessel wall with optimal size between 2 and 3 mm [1, 2].

The primary parameter is peak systolic velocity (VPS), which increases as the radius decreases to achieve a constant flow, until the stenosis is 90% or higher (subocclusion), when the resistance is so high that it descends gradually, with a value of 0 for occlusion [1, 4, 5]. Fig. 6 on page 9

When the degree of stenosis is indeterminate (contralateral carotid stenosis, tandem lesions, hyper or hypodynamic circulation) we must considerate other parameters: ICA/CCA PSV ratio and ICA end-diastolic velocity [1, 6]

We must avoid a false positive diagnosis of occlusion, because the treatment is different if it is a subocclusion. In near occlusion the objective is identify the "string sign", for that we must optimize the ultrasound parameters: decreasing pulse repetition frequency, increasing the color gain and reducing the wall filters [1, 2, 6]. Also we can use ultrasound contrast or ask for a second diagnostic technique (MRangiography, CTangiography or conventional angiography) [5].

In the case of a total carotid occlusion or proximal occlusion, it is characteristic a biphasic pattern known as "thud flow" [1, 3, 5] Fig. 7 on page 10. Other findings include the visualization in gray-scale imaging of the thrombus if it is chronic, as well as the absent flow with color Doppler imaging Fig. 8 on page 10, and internalization of the ECA in spectral analysis Fig. 9 on page 11 [1, 5].
Fig. 2: Homogeneous echolucent plaque in the proximal ICA (type 1).

© Department of Radiology, Hospital Clínico Universitario, Valladolid
**Fig. 3:** Homogeneous echogenic plaque with smooth surface (type 4).

© Department of Radiology, Hospital Clínico Universitario, Valladolid
Fig. 5: Heterogeneous and hypoechoic plaque in the CCA (type 2).

© Department of Radiology, Hospital Clínico Universitario, Valladolid
Fig. 4: Heterogeneous and echogenic plaque (type 3).

© Department of Radiology, Hospital Clínico Universitario, Valladolid
**Fig. 6:** Severe stenosis of the ICA (80-95%). Duplex US image: a. High PSV (318.8 cm/s). b. Distal to the stenotic segment, color flow turbulence and broadening of the Doppler spectrum.

© Department of Radiology, Hospital Clínico Universitario, Valladolid

---

**Fig. 7:** Thud flow.

© Department of Radiology, Hospital Clínico Universitario, Valladolid
Fig. 8: Echogenic thrombo and absent flow in color doppler.

© Department of Radiology, Hospital Clínico Universitario, Valladolid

Fig. 9: Internalization of the ECA.

© Department of Radiology, Hospital Clínico Universitario, Valladolid
Conclusion

- Carotid ultrasound, as a safe and reliable method, is the technique of choice in symptomatic patients.
- It is necessary to know the technical parameters and standardize the protocol to optimize the results.
Personal information

A. B. Gil Guerra. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

M. A. Schüller Arteaga. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

J. Galván Fernández. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

M. Rodríguez Velasco. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

S. Joral del Hoyo. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

P. Santos Velasco. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

R. Petruzzella Lacave. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

M. E. Gómez San Martín. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

M. Brahim Salek. Department of Radiology, Hospital Clínico Universitario. Valladolid, Spain.

Contact detail:
A. B. Gil Guerra, resident in training. Department of Radiology, Hospital Clínico Universitario. Av. Ramón y Cajal, 3, 47003, Valladolid (Spain).

E-mail: anagil.guerra@gmail.com
References


