6 Vessels of the neck

Mirco Cosottini, Maria Chiara Michelassi, Guido Lazzarotti

6.1 Introduction

The study of epi-aortic vessels can be performed with a variety of imaging techniques that provide morphological or functional information and show the vascular lumen of the vessel wall itself. From a technical point of view, these can be sub-grouped into invasive, such as Digital Subtraction Angiography (DSA), and into non-invasive or minimally invasive, such as Echo-Doppler, angio-Computed Tomography (CT), and Magnetic Resonance Angiography (MRA). This latter technique presents some advantages over angio-CT such as that of not using ionizing radiation and iodinated contrast agents, and of being more versatile in its reconstruction techniques thanks to the invisibility of the bone structures located in the field of investigation. Differently from other ultra-sonographic techniques, MRA allows a panoramic and objective view of the vascular district being examined, without the limit of a reduced field of view or of dependence on the operator.

6.2 Imaging techniques

Today, MRA techniques that are based on the principles of blood flow and allow the visualization of vessels without the use of a contrast agent have a limited role in the study of epi-aortic vessels. Contrast Phase (CP) sequence maintains a role in the evaluation of the vascular hemodynamics, while the Time of Flight (TOF) technique has been substituted by Contrast Enhanced MRA (CEMRA).

The diagnostic interpretation of magnetic resonance angiograms has been revolutionized by the ultrafast technique with contrast bolus. Indeed, in the techniques based on flow, the evaluation of the stenosing pathology is based on the effect of blood flow inside the vessel and requires experience in the reading and knowledge of the physical phenomena associated to flow in Magnetic Resonance Imaging (MRI); conversely, in contrast-enhanced techniques the angiogram is interpreted as a luminography, the same way as happens in conventional angiography.
6.3 Evaluation of epi-aortic vessels

MRA is usually performed with a super conductive magnet, preferably equipped with a high field and, necessarily, with high-performance gradients (maximum gradient strength >20 mT/m, slew rate >120 mT/m msec). The sequence utilized for CEMRA acquisition is a 3D fast SPGR on the coronal oblique plane, positioned along the sagittal plane after the acquisition of a scout image. In order to obtain a T1 for blood lower than that of the stationary tissue having a higher signal intensity, the operator must use a quantity of Gd-based contrast agent sufficient to reduce the blood’s T1 to values below 280 msec (280 msec is the T1 of fat tissue at 1.5 T). As to the other characteristics of the CEMRA, the reader is invited to go to the chapter on fast sequences. Here, we shall recall that in the case of supraortic vessels, in order to have a better visualization of the terminal branches of small caliber, an elliptic filling of K-space is recommended [1].

The parameters utilized in a typical sequence are: TR/TE 5.7/1.6 msec, FA 30°, NEX 0.5, matrix 192x256, zero filling in slice and frequency direction, bandwidth 62.5 KHz, thickness 1.8, 40 partitions, FOV 24 cm. Generally, this technique employs a phased-array coil dedicated to the neurovascular structures of the neck. Some coils in commerce today allow the contemporary visualization of the carotid-vertebral axes and the epi-aortic vessels emerging from the arc thus allowing the study to be performed in a single acquisition.

The injection with contrast bolus is performed through the use of a MR-compatible automatic injector, using 0.2 mmol/kg of paramagnetic contrast agent that is injected intravenously at a constant rate (e.g. 2 ml/sec).

CEMRA images are then transferred to a dedicated workstation and reformatted by the reconstruction algorithms: Maximum Intensity Projection (MIP) and Multiplanar Volume Reconstruction (MPVR). Similarly, 3D volume reconstructions can be made.

In the case of steno-occlusive pathology of the cerebral ascending vessels, the CEMRA procedure can be preceded by a hemodynamic evaluation with Fast PC axial scanings or cine-PC positioned in the most vertical tracts of the carotid siphons and of the basilar artery. If requested, the CEMRA investigation can be preceded by the MRA of the intracranial vessels (see Chapter 5). When dissection of the carotid a. or of the vertebral a. is suspected or already acknowledged, it is necessary that CEMRA be preceded by T1- weighted axial scanning on the axis of the vertebral carotid, possibly with a spectral fat-saturation pulse to establish the presence of a sub-intimal hematoma.

Some MR machines do not have coils specific for MRA studies of the cerebral ascending vessels; therefore, the anatomic coverage of the emergence of epi-aortic vessels is not properly guaranteed by the coils dedicated to the examination of the neck. In such situations, it is necessary to perform a separate study on the emergence of epi-aortic vessels with surface coils or phased-array coils that are normally utilized for the study of the abdomen.