

## Non-contrast-enhanced MRA of the Carotids :Feasibility of a non-ECG-gated sequence over an extended field of view

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**Target audience :** neuroradiologists, MR physicists

### Purpose

Detecting internal carotid artery (ICA) stenosis is a main challenge for the prevention of stroke, the third leading cause of death in the developed world. Novel non-contrast-enhanced MRA (NCE MRA) sequences have emerged as an alternative to traditional MRA approaches<sup>1</sup>, especially for patients during pregnancy or with renal insufficiency. Up to now, the inversion-prepared bSSFP NCE MRA approach has been applied to imaging of renal arteries or kidney transplants<sup>2</sup> and only few studies focused on the ICA, using ECG-gating<sup>3</sup>. The purpose of this study was to assess the feasibility and image quality of an improved non-gated carotid NATIVE TrueFISP NCE MRA sequence providing an extended field of view as compared to Time-of-Flight (TOF) imaging.

### Methods

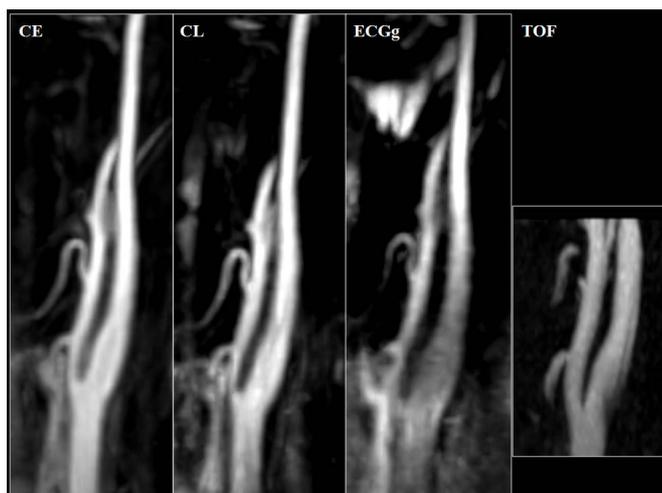
After approval from the local ethics committee, 16 healthy subjects underwent NCE MRA carotid imaging on a 3T system (MAGNETOM Verio, Siemens Healthcare), using the 12-ch head and 4-ch neck matrix coils. The basic principle of the used technique is to prepare the volume of interest with a slice-selective inversion and to acquire data after an inversion time TI to suppress signal from stationary tissue and venous blood. Imaging parameters were: FOV=340x243mm<sup>2</sup>, 88 slices, 0.9x0.9x0.9mm<sup>3</sup> voxel size, TR/TI/TE=3500ms/1600/1.71ms, 90° flip angle, GRAPPA 2, 2min50s scan time. In phase-encoding direction, a Partial Fourier factor of 6/8 was used. A sampling scheme acquiring the k-space center early in the acquisition window ("k-space center early"/kCE) was compared to a scheme sampling the k-space center late during the acquisition ("k-space center late"/kCL). The imaging protocol included three NCE MRA sequences (kCE/kCL without gating and kCE with ECG-gating (ECGg) as well as reduced TR to fit into the RR interval) and TOF (FOV=200x181mm<sup>2</sup>, TR/TE=20 ms/3.19 ms, 4min45s scan time). Carotid NCE MRA images were reviewed with respect to image quality and intravascular signal quantification, and compared with TOF.

### Results

Carotid NCE MRA was successfully performed in all patients (representative subject in fig.1). For all criteria, image quality was higher with kCE than with the kCL scheme. kCE image quality was higher without ECG gating and was comparable with TOF or higher (table 1) because of improved signal homogeneity. Intravascular signal was comparable at the level of proximal and distal ICA and higher with kCE.

|                             | kCE    | kCL   | ECGg | TOF |
|-----------------------------|--------|-------|------|-----|
| overall quality             | 2.9*   | 2.6   | 1.2* | 2.3 |
| vessel delineation          | 2.4    | 2.3   | 1.2  | 2.4 |
| vascular signal homogeneity | 2.4*   | 1.9   | 1.1* | 1.5 |
| proximal ICA: signal        | 2184 * | 1408* | 882* | 330 |
| distal ICA: signal          | 2060   | 1353  | 996  | NA  |

**Table 1.** Image quality (from 0: bad to 3: excellent) and intravascular signal and contrast values for all 3 NCE MRA sequences and TOF. \*: significant difference with TOF ( $p < 0.05$ ).



**Figure 1.** MIP (20 mm) sagittal views for kCE, kCL, ECGg NCE MRA and TOF.

### Discussion

In comparison to standard TOF, the used NCE MRA sequence offered equivalent to higher image quality along with larger coverage and shorter acquisition times. Improved image quality was achieved without ECG gating, which had been used in previous studies<sup>3</sup>. A Partial Fourier scheme with an early acquisition of k-space center yielded higher image quality and signal intensity compared to a late acquisition.

### Conclusion

Non-gated inversion-prepared bSSFP carotid imaging offers high-quality images and allows analysis of the ICA over an extended field of view. Further work will evaluate the ability of this sequence to detect and quantify stenosis, both on phantoms and patients.

- References :** 1. Nael K, Villablanca JP, Pope WB, et al. Radiology. 2007;242(2):600-609.  
2. Lanzman RS, Voiculescu A, Walther C, et al. Radiology. 2009;252(3):914-921.  
3. Kramer H, Runge VM, Morelli JN, et al. Eur Radiol. 2011;2(8)1:1667-1676.