# A comparative study of 3D time of flight MRA and contrast-enhanced MRA :Clinical and phantom studies

**Y. Saito[1], M. Osanai[1], K. Oyu[1], K. Hamada[1], and H. Yodono[2]**

[1]Graduate School of Health Sciences, Hirosaki University, Hirosaki, Aomori, Japan, [2]Radiology, Narumi Hospital, Hirosaki, Aomori, Japan

## Purpose

Head and neck MRA are now widely used in many clinical settings. In our institute, 3-dimentional-time of flight MRA (3D-TOF MRA) of the head and contrast–enhenced 3D MRA (CE-MRA)of the neck are routinely performed. MRA is well known to have a tendency to overestimate the stenotic degree. However, few comparative studies of different MRA techniques have been reported. The purpose of this study is to evaluate the stenotic degree of arteries at the skull base level which are demonstrated on both 3D-TOF head MRA and CE-MRA of the neck with clinical and phantom studies.

## Methods

### Clinical study

We examined 139 cases. Ninety-six were male and forty-three were female with age of 42 to 84 years old.

All imaging was performed using 1.5T superconducting MR system with neurovascular phased array coils. The imaging parameters of head MRI and neck CE-MRA were as follows: head MRA; SPGR (TR=40,TE=6.9 ms., FA=20deg, FOV= 16x16cm,matrix=320x160, slab/slice thickness=68/1.2mm, ZIP=2, data acquisition time=7m.32s. ) Neck CE MRA: FSPGR (TR=4.2,TE=1.1ms, FA=20deg.,FOV= 30x30cm ,Matrix=320x256, slab/slice thickness=72/2mm,ZIP=4, data acquisition time =46s.) with elliptical centric view ordering. 0.2ml/Kg of Gd-DTPA was injected via antecubital vein at a speed of 2ml/s with a power injector. Timing scan using 1ml of Gd-DTPA had been performed before CE MRA data acquisition to determine the delay time. Maximum Intensity Projection (MIP) post-processing technique was used to obtain angiographic imaging. Five arteries (bilateral internal carotid arteries, bilateral vertebral arteries and basilar artery) in each case were evaluated. In total 695 arteries were assessed for patency. Each artery was assessed for patency according to the following schema: a)no significant stenosis (stenosis:~49%), b)mild stenosis(stenosis:50~74%), c)severe stenosis (stenosis:75~99%), d) occlusion(100%).IA-DSA was not performed in any case.

### Phantom Study

The diluted contrast materials that showed the same $T_1$ value as arterial blood before（1200ms） and after enhancement（100ms） were perfused into the tortuous vessel phantom(diameter:2.0& 3.0mm) with a pump at the speed of 20 and 50cm/sec. Head TOF MRA and CE-MRA were obtained with different parameters: imaging planes (axial, coronal), slice thickness(1.0,1.6,2.0,3.2,4.0,.6.4,8.0mm), ZIP(0,2,4,8), and reduction factors (1.0,1.5,2.0)in parallel imaging. FOV(20x20cm)and matrix(256x256) were not changed. The Diameters of phantom lumen were measured on MIP images and compared with the actual lumen diameters. SNR was also assessed. For statistical evaluation, unpaired t-test was used.

## Results

### Clinical study

In 86 out of 139 cases(62%) and 615 out of 695 arteries(89%), the stenotic degrees were estimated as in the same category on both techniques. In 53 out of 139 cases(38%) and in 80 out of 695 arteries(11%), the discrepancy between two technique in grading arterial steoses occurred. In 70 out of 80 arteries(88%), the stenotic grading were more severely estimated with neck MRA than with head MRA. Most of these discrepancies occurred in carotid siphon.

### Phantom Study

TOF MRA tended to demonstrate the phantom more accurately than CE-MRA. On TOF MRA with 1.6mm slice thickness, diameters were more accurate than TOF MRA with 1mm thickness.

In coronal CE-MRA, diameters on the frontal MIP images were underestimated. ZIP reduced these tendencies but the effects were limited. The diameters with ZIP2 were closer to actual tube diameters than those with ZIP4.Both on the frontal and lateral MIP images, diameters of the tube were significantly more accurate with parallel imaging than with ZIP. Flow speed didn’t affect on the diameters on any sequence.

## Discussion

CE-MRA is also widely accepted as one of non-invasive modality to evaluate vascular disease. In clinical study, we evaluated the stenotic degree of arteries at the skull base level which are demonstrated both on head TOF MRA and neck CE-MRA. In cases with discrepancy, more arteries were categorized into more severe categories on CE-MRA than on 3D TOF MRA. It is confirmed that CE-MRA has a tendency to overestimate the stenotic degree.

From our phantom study, not only high spatial resolution but also high SNR is thought to affect on be necessary for the accurate depiction of narrow vessels on TOF MRA. Parallel imaging is thought to be more valuable than ZIP in CE-MRA.

The tendency of underestimation of lumen diameters on CE MRA was also confirmed with our phantom studies. This might be a main cause of overestimation of stenotic degree in our clinical study.

We should keep in mind that any MRA images tend to overestimate the stenotic degree and therefore we should carefully evaluate the MRA images.