Title:

Optimal velocity encoding in preoperative vascular assessment magnetic resonance angiography for transradial/transulnar neurointervention

Synopsis:

Motivation:

The optimal VENC setting for the 3D PC imaging of radial/ulnar arteries remains unclear.

Goal:

We aimed to investigate the optimal VENC setting of radial/ulnar arteries.

Approach:

All patients underwent MRA imaging using the 3D PC method with three different VENC settings (15, 30, and 45). The SNR of radial/ulnar arteries was calculated. The differences in mean SNR were assessed using Kruskal–Wallis analysis with post hoc pairwise comparisons. Five cerebrovascular treatment specialists assessed the clarity and visual quality of the radial/ulnar artery imaging.

Results:

The SNR and average degree of preference were high for a VENC setting of 15.

Impact:

A VENC setting of 15 is appropriate for MRA imaging of radial/ulnar arteries using the 3D PC method, allowing preoperative vascular evaluation in transradial/transulnar neurointervention. However, the VENC settings for younger patients should be determined after consultation with clinicians.

Authors and Affiliations:

Authors: Ryuya Okawa[1,2)], Norio Hayashi[3)], Go Yasui[1)], Kazunori Akaji[4)], Ban Mihara[5)]

1) Department of diagnostic imaging, Institute of Brain and Blood Vessels Mihara Memorial Hospital

2) Graduate School of Radiological Technology, Gunma Prefectural College of Health Sciences

3) Department of Radiological Technology, Gunma Prefectural College of Health Sciences

4) Department of Neurosurgery, Institute of Brain and Blood Vessels Mihara Memorial Hospital

5) Department of Neurology, Institute of Brain and Blood Vessels Mihara Memorial Hospital

Body of the Abstract:

Background

In transradial/transulnar neurointervention (TRN/TUN), preoperative vascular evaluation is crucial for identifying loops and tortuosity in the puncture site [1-5]. We use the 3D phase contrast (PC) method for the magnetic resonance angiography (MRA) of the radial/ulnar artery. If the velocity encoding (VENC), one of the parameters, is not set appropriately, the visualization of the target vessel is compromised. Previous studies have established VENC settings for brain/thoracic vessels, etc. [6-8]. However, the optimal VENC for the radial/ulnar artery remains unclear. This study aimed to investigate the optimal VENC of the radial/ulnar artery for preoperative evaluation of TRN/TUN.

Methods

Patients with underwent preoperative vascular evaluation MRA imaging for TRN/TUN at our institution were retrospectively examined. The MRI systems used to acquire the MRA images were Signa Artist 1.5 Tesla scanner and a 30-channel AIR Anterior Array Coil as the receiving coil (General Electric Healthcare Medical Systems Corporation, Milwaukee, Wisconsin, USA). All patients underwent MRA imaging using the 3D-PC method with three different VENC settings (15, 30, and 45). For quantitative evaluation, a region of interest (ROI) was placed in the radial/ulnar artery, and the signal intensity and standard deviation were measured. The original MRA image was used to set the ROI, and the same coronal section was used as the imaging section. The signal-to-noise ratio (SNR) of the radial/ulnar arteries was calculated using the identical ROI method. The Kruskal-Wallis analysis and post hoc pairwise comparisons were used to evaluate the differences in the mean SNR of the radial/ulnar artery. Five cerebrovascular treatment specialists evaluated the visual clarity of the radial/ulnar artery, using the Scheffé's method (Nakaya's changing method). For each patient, three sets of evaluation images were created by combining three different images captured at different VENC settings (Figure 1). Subsequently, a pair of the combined evaluation images was randomly displayed on a medical imaging monitor, and the relative visual clarity of the left image was compared with that of the right image. The evaluation images consisted of the maximum intensity projection (MIP) images commonly used by physicians for preoperative vascular evaluation. The images were rated on a 5-point scale: 2, good; 1, slightly good; 0, similar; −1, slightly poor; and −2, poor.

Results

The study included 10 patients (aged 52–87 years, mean age: 74.1±10.5, male:female ratio: 5:5). Figures 2 and 3 show the comparison of the mean SNR of the radial/ulnar artery in each VENC setting using a multiple comparison test. The multiple comparison test of the radial artery showed no significant difference in the mean SNR between VENC 30 and 45, while all other pairwise comparisons showed significant differences ($p<0.05$). Meanwhile, the multiple comparison test of the ulnar artery revealed significant differences in the mean SNR across all VENC settings ($p<0.05$). VENC 15 yielded the highest mean SNR values for the radial/ulnar arteries, while VENC 45 yielded the lowest values. However, one patient showed a higher SNR at a VENC setting of 30. Figure 4 illustrates the representative MRA MIP images obtained at three different VENC settings. Although the radial/ulnar arteries were visible in all VENC settings, the visualization quality differed depending on the VENC settings. The average degree of preference using the Scheffé's method were 1.64 for VENC 15, 0.84 for VENC 30, and −1.16 for VENC 45 (Figure 5). The visual evaluation scores significantly differed among all VENC settings ($p<0.001$), with VENC 15 obtaining the highest scores and VENC 45 yielding the lowest scores.

Conclusions

The SNR and average degree of preference were highest for VENC 15. As the VENC settings depend on the blood flow velocity of the target vessel, lower velocities require smaller VENC values. The radial/ulnar arteries have smaller diameters and lower blood flow velocities than other large vessels. Therefore, we concluded that lower VENC settings result in higher signal intensity, SNR, and average degree of preference. However, one case showed a high SNR for VENC 30. Results of the patient information survey indicated that the high SNR at VENC 30 was attributed to younger age, a large vessel diameter, and a high blood flow velocity. Based on the SNR and visual evaluation results, we concluded that a VENC setting of 15 is appropriate for the preoperative vascular evaluation of TRN/TUN using the 3D PC method. However, in some cases, such as young patients with large vasculature and high blood flow velocity, a VENC setting of 30 may be more suitable. Therefore, it is necessary to determine the VENC setting after consultation with the clinician.

References

1. Luther E, Burks J, Abecassis J, et al. Navigating radial artery loops in neurointerventions. J Neurointerv Surg 2021 ; 13: 1027-31.
2. Folmar J, Sachar R, Mann T, et al. Transradial approach forcarotid artery stenting : a feasibility study. Catheter Cardiovasc Interv 2007 ; 69 : 355-361.
3. Pinter L, Cagiannos C, Ruzsa Z, et al. Report on initial experience with transradial access for carotid artery stenting. J Vasc Surg 2007 ; 45 : 1136-1141.
4. Patel T, Shah S, Ranjan A, et al. Contralateral transradial approach for carotid artery stenting : a feasibility study. Catheter Cardiovasc Interv 2010 ; 75 : 268-275.
5. Mendiz OA, Sampaolesi AH, Londero HF, et al. Initial experience with transradial access for carotid artery stenting. Vasc Endovasc Surg 2011 ; 45 : 499-503.
6. Mehta MP, Petereit D, Turski P, et al. Magnetic resonance angiography: A three-dimensional detabase for assessing arteriovenous malformations. J Neurosurg 1993 ; 79: 289-293.
7. Miyazaki M, Lee VS. Nonenhanced MR angiography. Radiology 2008 ; 248(1) : 20-43.
8. Basant P, Masayuki S, Kazunori A, et al. Usefulness of three-dimensional phase contrast MR angiography on arteriovenous malformations. Neurosurgical Review 1997 ; 20 : 171-176.

Sources of funding

No funding was received for this study.

Declaration of interest

The authors declare that they have no declaration of interest.

Figures:

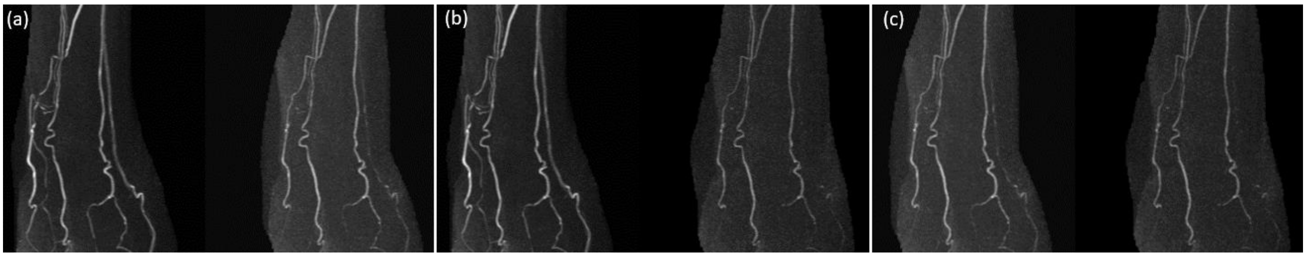

Figure 1

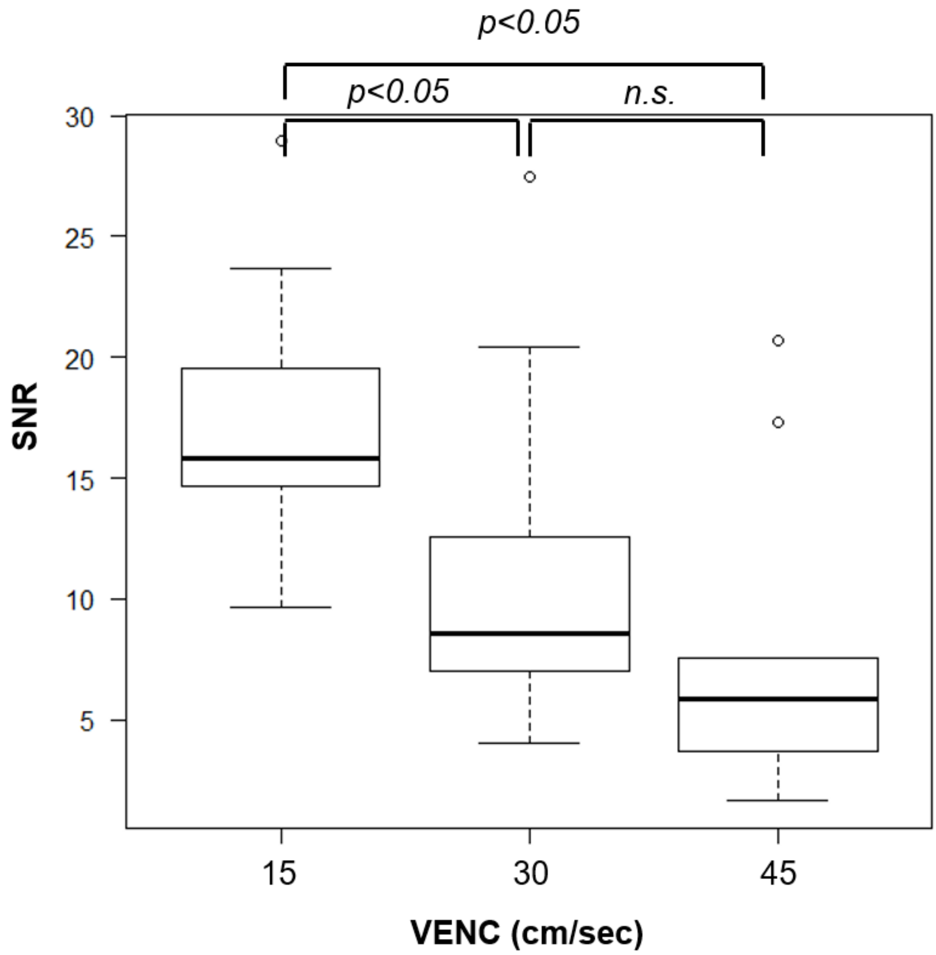

Figure 2

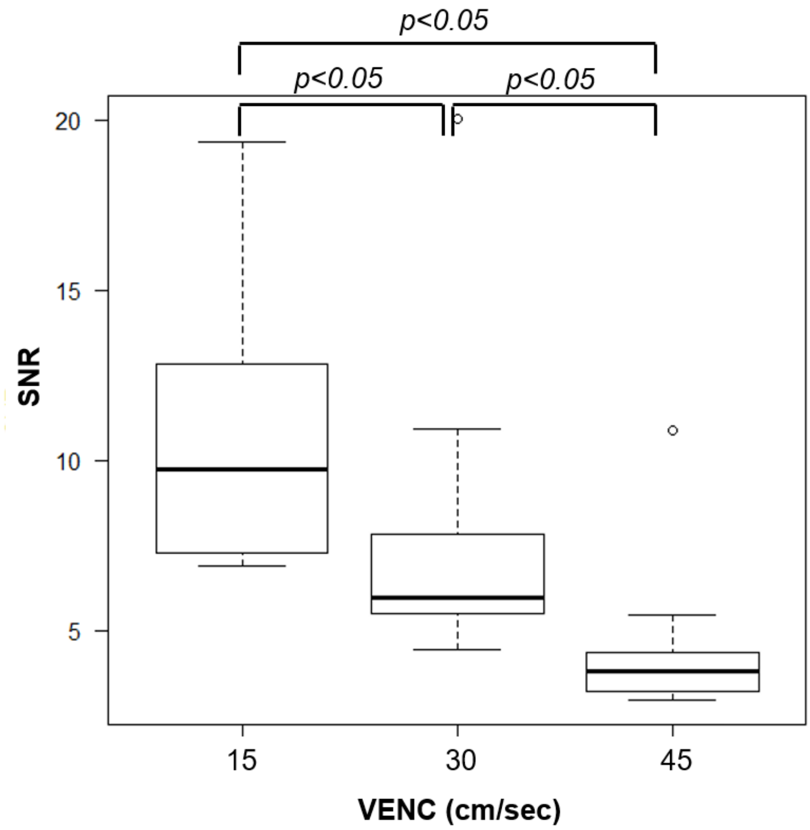

Figure 3

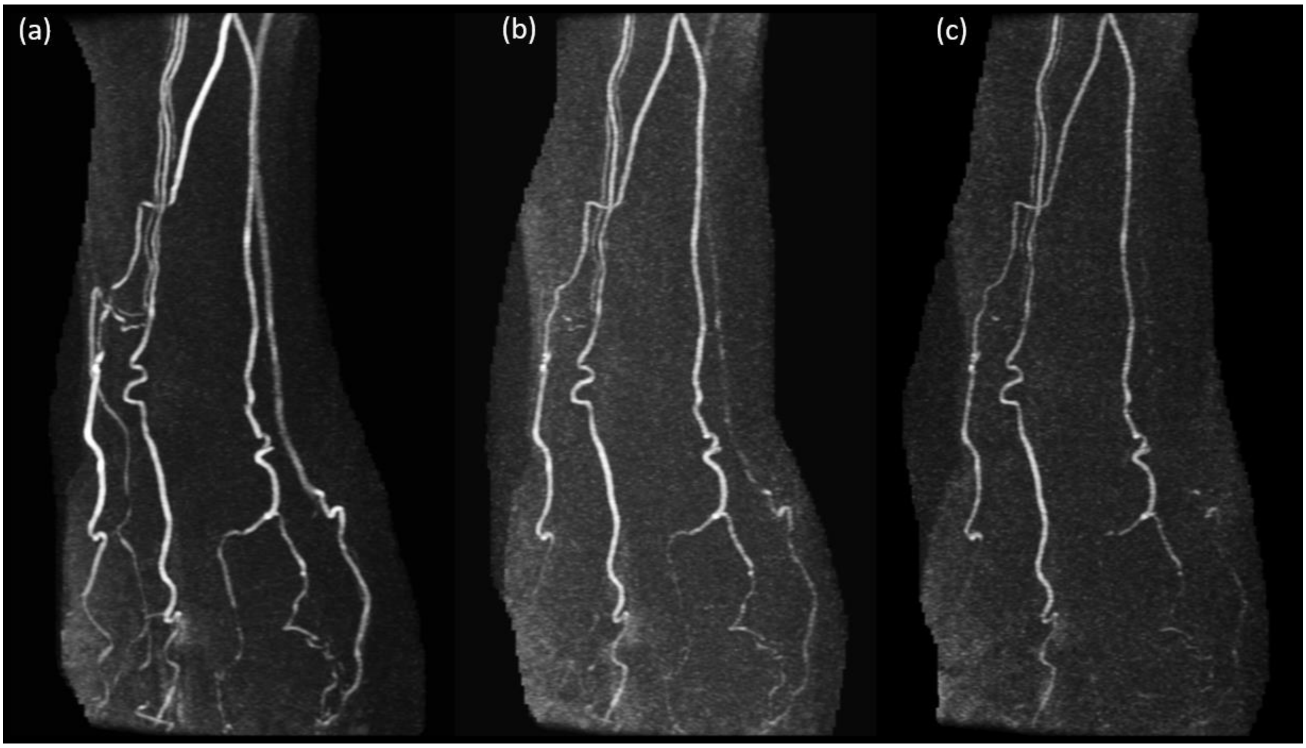

Figure 4

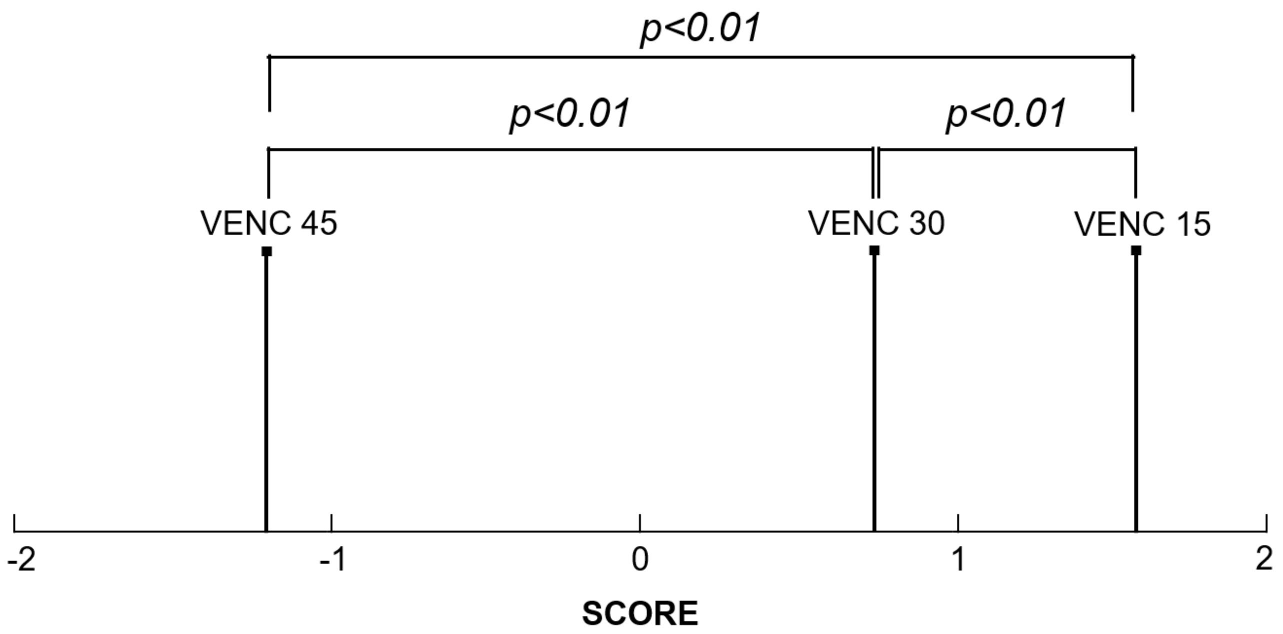

Figure 5

Figure Captions: 500 characters per caption

Figure 1. Three sets of evaluation images were created by combining three different images captured at different VENC settings
(a) VENC 15 (left image) and VENC 30 (right image), (b) VENC 15 (left image) and VENC 45 (right image), (c) VENC 30 (left image) and VENC 45 (right image)

Figure 2. Comparison of the mean SNR of the radial artery in each VENC setting using a multiple comparison test

Figure 3. Comparison of the mean SNR of the ulnar artery in each VENC setting using a multiple comparison test.

Figure 4. The representative MRA MIP images obtained at three different VENC settings
(a) VENC 15, (b) VENC 30, (c) VENC 45

Figure 5. Comparison of average degree of preference between each VENC setting in Scheffé's method