

ABSTRACT

Background: The condition of vestibular functions and blood flow in the vertebral artery (VA) in vertebrobasilar insufficiency (VBI) is not well established.

Objectives: To clarify the pathophysiology of VBI, especially the difference between the conditions with or without central nervous system symptoms.

Materials and Methods: Ten VBI patients with central nervous system symptoms (VBI/w) and 12 VBI patients without central nervous system symptoms (VBI/o) underwent duplex color-coded ultrasonographic evaluation of VAs, and the vestibular functions evaluated with caloric test, and cervical vestibular-evoked myogenic potential (cVEMP) testing were compared.

Results: The mean flow (MV) ratio (peak MV of contralateral VA divided by target VA) was significantly higher in VBI/w than in VBI/o. There was no difference in the occurrence of canal paresis on caloric test between VBI/w and VBI/o. Abnormal asymmetry ratios (ARs) of cVEMP were observed only in VBI/o cases (6 of 12 cases), revealing a statistically significant difference in the number of cases between VBI/w and VBI/o.

Conclusions and Significance: Measuring VA conditions using duplex color-coded ultrasonography and cVEMP may help evaluate VBI. Different results of MV ratio and cVEMP between VBI cases with or without central nervous system symptoms may indicate the differences in pathophysiology between VBI/w and VBI/o.

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INTRODUCTION

Episodic vertigo is a common symptom of transient ischemia of the vertebrobasilar system. Transient ischemic attacks (TIA) without brain infarction caused by posterior circulation ischemia can be diagnosed as vertebrobasilar insufficiency (VBI). The diagnosis of VBI is based on having at least some episodes of vertigo with the characteristic combination of symptoms that include dizziness, diplopia, drop attacks, unsteadiness, headache, hearing loss, loss of consciousness, dysarthria, and numbness¹. Such clinical conditions are defined as ‘transient vascular vertigo/dizziness’ in the diagnostic criteria by the Bárány Society².

Although more than half of VBI cases showed isolated episodes of vertigo as the initial symptom³, some institutions treating strokes do not embrace treating isolated vertigo as a TIA symptom involving the vertebrobasilar territory. Furthermore, the condition of vestibular functions and blood flow in the vertebral artery (VA) in VBI is not well established.

In the present study, we investigated the relationship between the results of duplex color-coded ultrasonography of VAs and neurologic vestibular examinations in VBI cases to elucidate the etiology of vascular vertigo and dizziness. The aim was to clarify the pathophysiology of VBI, especially the difference between the conditions with or without central nervous system (CNS) symptoms.

METHODS AND MATERIALS

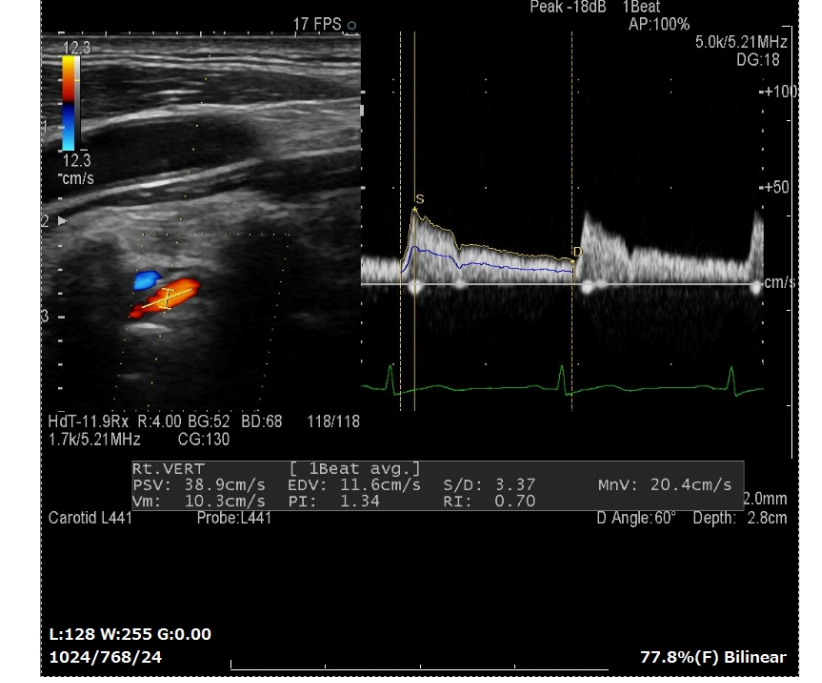
We retrospectively assessed 22 patients with VBI who visited our department between November 2017 to December 2021. We excluded patients diagnosed with other vestibular dysfunctions simultaneously. The participants were divided into two groups depending on whether they presented CNS symptoms other than vertigo/dizziness (VBI with CNS symptoms: VBI/w, VBI without CNS symptoms: VBI/o). Dizziness Handicap Inventory (DHI), MRA and MRI, duplex color-coded ultrasonography, caloric test and cVEMP were assessed.

< Duplex color-coded ultrasonography >
The diameter and flow velocities of both VAs were measured before treatment using B-mode scans with color imaging and pulse doppler. We obtained the end-diastolic flow velocity (EDV) and time-averaged peak mean flow velocity (MV) was corrected using adequate angle for both VAs. The diameter ratio and MV ratio (diameter/MV of contralateral VA divided by the target VA) were also determined. We evaluated the patients’ VAs according to the criterion proposed by Saito⁴ (Figure 1).

< Duplex color-coded ultrasonography >
We measured both VAs at the C3-4, C4-5, or C5-6 levels of the cervical spine.



Technical guide to the Carotid Ultrasonography. Shindan to Chiryō-Sha, Tokyo, Japan.



DISCUSSION

- ✓ Many cases in the present study were diagnosed as normal by the VA occlusion criterion [Saito]. However, all our patients were determined abnormal if any of the negative EDV, $MV \leq 18$ cm/s, $MV\text{-ratio} \leq 1.4$, or diameter-ratio ≤ 1.4 is met. It may be better to set the threshold of VA insufficiency for VBI lower compared to patients with cerebral infarction or TIA.
- ✓ cVEMP testing results showed abnormal only in the VBI/o group. The different rates of unilateral saccular dysfunction indicates that the affected area of the vestibular system might differ between VBI/w and VBI/o.
- ✓ Caloric testing results did not show a statistically significant difference between VBI/w and VBI/o. The different aspects in the results of the cVEMP and caloric test may be related to the difference in reflex pathways between the examinations, descending and ascending from the vestibular nuclei.

RESULTS

Table 1. Summarized data of patients.

	VBI/w	VBI/o	P value
Number of cases	10	12	
Sex (male/female)	5/5	5/7	0.51†
Age (mean, SD)	65.7, 12.2	70.4, 12.4	0.81‡
DHI (mean, SD)	36.4, 18.7	40.8, 20.8	0.7§
Ultrasonography			
Insufficiency side (R/L)	8/2	12/0	
Diameter (affected side) (mean, SD)	2.55, 0.70	2.82, 0.88	
Mean flow velocity (MV) (mean, SD)	15.6, 5.20	18.7, 4.77	
MV-ratio (mean, SD)	2.05, 0.75	1.46, 0.24	
Caloric test (Normal / abnormal)	5/5	4/8	0.36†
cVEMP (Normal / abnormal)	10/0	6/6	0.01†

†: Fisher's exact probability test
‡: Student's t-test
§: Welch's t-test

Figure 2. Ultrasonographical evaluation of vertebral arteries.

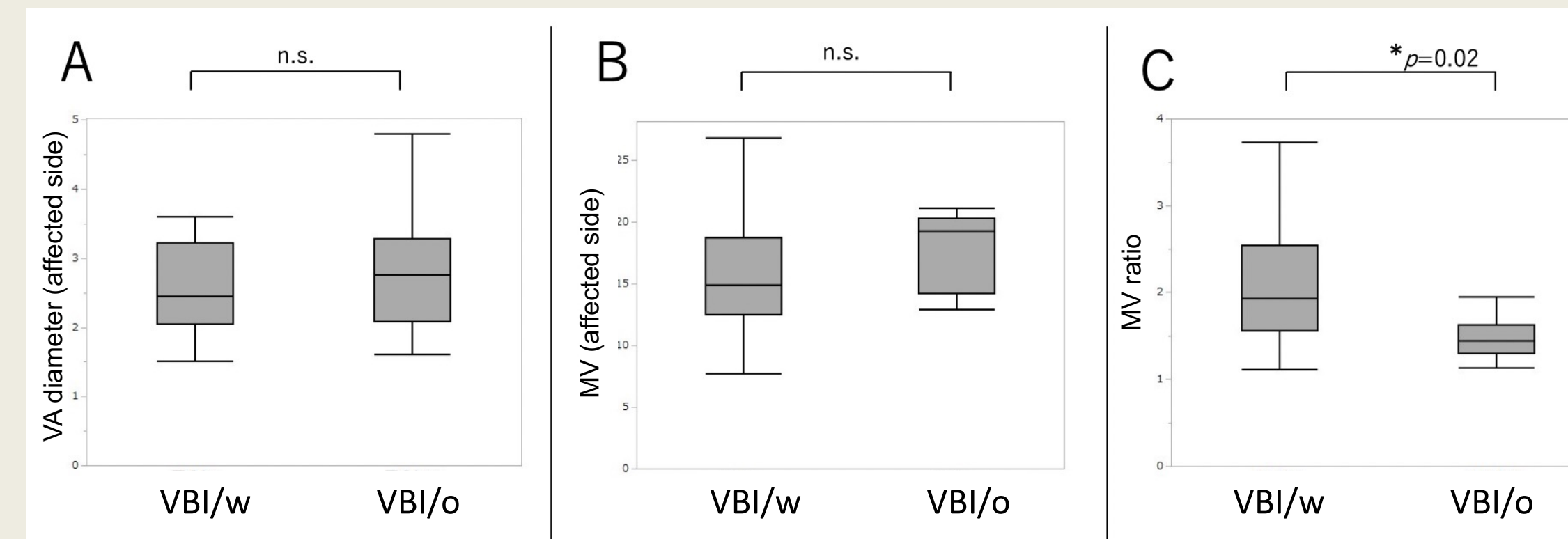
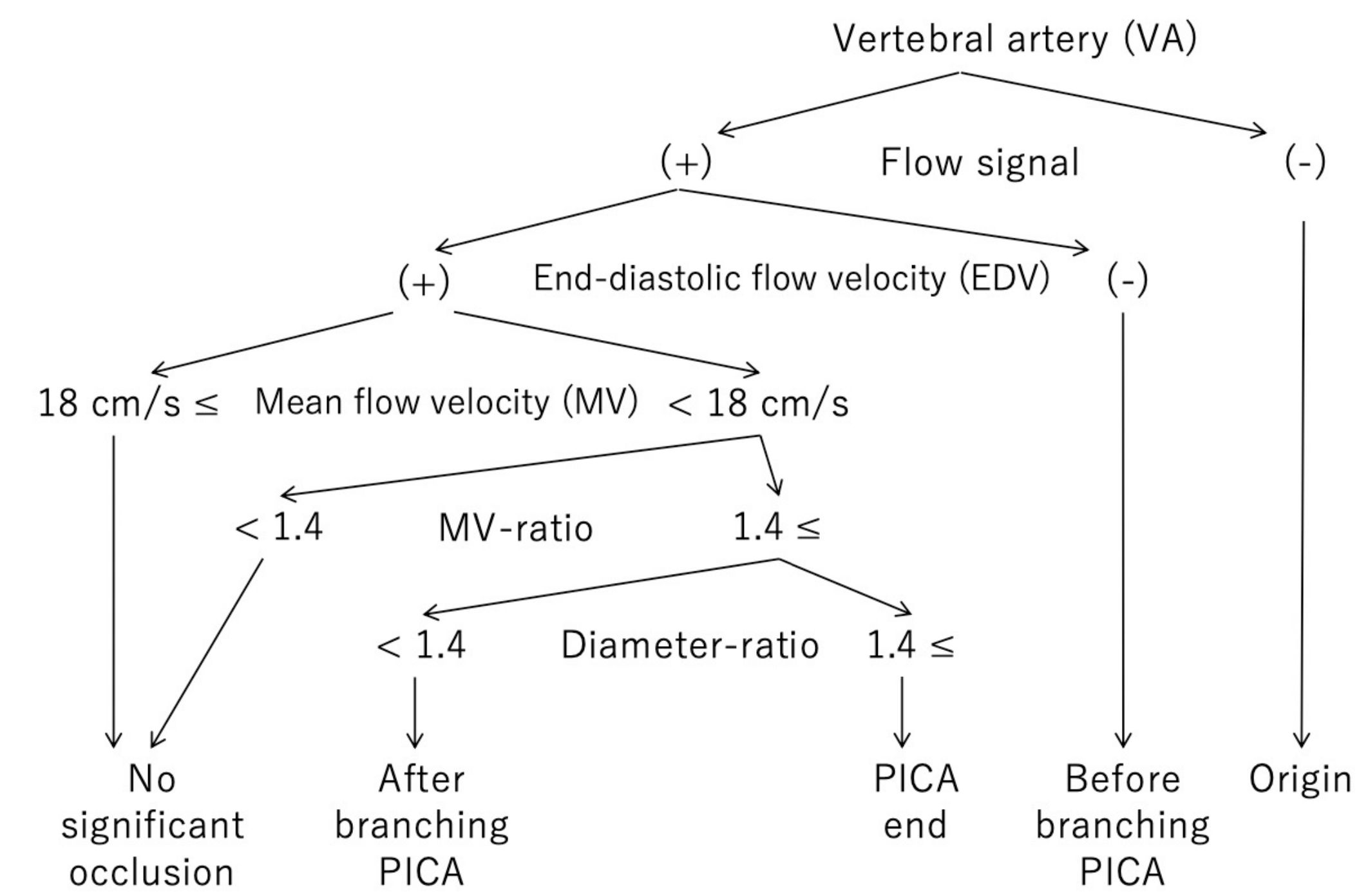


Figure 1. Ultrasonographic diagnostic algorithm for the site of vertebral artery occlusion (Saito, 2004).



MV ratio: peak mean flow velocity (MV) of the contralateral vertebral artery (VA) divided by the of the target VA; PICA: posterior inferior cerebellar artery.

CONCLUSIONS

Measuring the blood flow velocity and diameter of the VAs using duplex color-coded ultrasonography may help evaluate VBI. Different results of the cVEMP and MV ratio between VBI cases with or without CNS symptoms may indicate a discrepancy in pathophysiology between VBI/w and VBI/o.

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