Vertebral Artery Hypoplasia and Posterior Circulation Infarction in Patients with Isolated Vertigo with Stroke Risk Factors

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Background: We aimed in this study to investigate the prevalence of vertebral artery hypoplasia (VAH) in a population with isolated vertigo in association with stroke risk factors, to determine whether VAH is an independent risk factor for posterior circulation infarction (PCI). *Methods:* We sequentially enrolled 245 patients with isolated vertigo with at least 1 vascular risk factor, who were divided into PCI and non-PCI groups, according to present signs of acute infarction on diffusion-weighted magnetic resonance imaging. All patients underwent magnetic resonance angiography and cervical contrast-enhanced magnetic resonance angiography to screen for VAH. Univariate and multivariate logistic regression analyses were performed to identify the significant risk factors for PCI. *Results:* VAH was found in 64 of 245 patients (26%). VAH (odds ratio [OR] = 2.70, 95%confidence interval [CI] 1.17-6.23, $P = .020$), median stenosis of the posterior circulation (OR = 7.09, 95%CI = 2.54-19.79, $P < .001$), and diabetes mellitus (OR = 3.13, 95%CI 1.38-7.12, $P = .006$) were independent risk factors for PCI. The predominant Trial of Org 10172 in Acute Stroke Treatment subtype in our patients with isolated vertigo with PCI complicated by VAH was mainly small-artery occlusion. *Conclusions:* Our findings suggest that VAH is an independent risk factor for PCI in patients with isolated vertigo with confirmed risk from stroke. **Key Words:** Vertigo—vertebrobasilar insufficiency—hypoplasia—vertebral artery—stroke.

Introduction

Vertigo is a common complaint among patients examined by neurologists. This distressing condition covers a range of disorders of spatial orientation and motion perception, such as the illusion of rotatory motion.[1] Isolated vertigo, which is one of the most common forms of vertigo in the elderly,[2] refers to the occurrence of vertigo in the absence of positive signs of central neurological system disorder on physical examination.[3] Isolated vertigo can arise because of a posterior circulation infarction (PCI), transient ischemic attack of the vertebrobasilar system, and other medical causes.[4] With the widespread availability in recent years of radiological examination of the cerebral vessels, clinician researchers have made the incidental observation that congenital anatomical variations of both vertebral arteries are not an uncommon phenomenon. In clinical practice, some symptomatic patients

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have unilateral or bilateral vertebral artery hypoplasia (VAH)[5,6]; an abnormally narrow luminal diameter of a vertebral artery may impart risk for infarct and be a causative factor for vascular vertigo.

Left vertebral artery dominance is reported to be present in 50% of the normal population, whereas both vertebral arteries are of similar size in only 25% of the population.[7] VAH is observed as an incidental finding in approximately 12% of healthy individuals.[8] Because of its high prevalence, VAH is considered to be a vascular variant without clinical significance. However, emerging evidence from case reports,[5] imaging findings,[9] and cohort studies[10] suggests that VAH may in fact be a predisposing factor for PCI, especially when it occurs along with other conventional vascular risk factors.[11] In addition, it has been reported that VAH is associated with migraine with aura[12,13] and vestibular neuronitis.[14]

Given the importance of this common vascular variant in relation to the risk of clinical stroke, our knowledge of the occurrence of VAH in patients with isolated vertigo is fairly limited, and it remains uncertain whether VAH is a risk factor for PCI. Therefore, we aimed to investigate the prevalence and risk relationships of VAH with isolated vertigo for PCI and to analyze the relevant characteristic Trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria in these patients.

Patients and Methods

Study Population

A total of 523 patients with vertigo were enrolled from January 2014 to October 2015 in the Neurology Department of Zhengzhou People's Hospital. The inclusion criteria were as follows: patient age > 18 years old; had at least 1 vascular risk factor (age > 60 years old; male; with hypertension, diabetes, lipid metabolism disorders, obesity, hyperhomocysteinemia, coronary atherosclerosis heart disease, smoking, or alcoholism); and had negative results for the Dix–Hallpike test and roll test. Patients were excluded if they had benign positional vertigo (105 patients), vertigo with signs of focal neurological damage (58 patients), Meniere's disease (32 patients), atrial fibrillation (23 patients), vertigo caused by aural or ophthalmic disease (21 patients), cerebral hemorrhage (16 patients), recurrence of cerebral infarction (6 patients), anterior circulation infarction (4 patients), infection (4 patients), congenital heart disease (4 patients), a brain tumor (2 patients), or vertigo caused by poisoning or systemic diseases (2 patients) or trauma (1 patient). There remained 245 patients with isolated vertigo in association with 1 vascular risk factor.

Of the 245 patients, 21 were excluded from consideration because of incomplete clinical data; 10 subjects refused to participate in this clinical research, 8 had only magnetic resonance angiography (MRA) or cervical contrast-enhanced MRA (CEMRA), and 3 patients had poor image quality. The remaining 224 patients were divided into PCI (whose culprit artery was not originated from internal carotid artery system, such as fetal posterior cerebral artery pattern) and non-PCI groups, according to whether acute infarction was found in diffusion-weighted magnetic resonance imaging (MRI). The TOAST classifications[15] of the patients in the PCI group were recorded on the day of admission. The TOAST subtypes present in our study group included large-artery atherosclerosis (LAA), small-artery occlusion (SAO), cardioembolism, stroke of other determined etiology, and stroke of undetermined etiology.

Written informed consent was obtained from each participant. This single-center study was approved by the ethics committee of Zhengzhou People's Hospital.

Magnetic Resonance Examination Protocol

MRI (GE Signa HDX 3.0 Tesla, Fairfield, CT) was performed on each patient within 72 hours after hospitalization. The acquisition included T1- and T2-weighted imaging, fluid-attenuated inversion recovery, and diffusion-weighted MRI. All subjects underwent 3-dimensional time-of-flight MRA and CEMRA with gadopentetate dimeglumine contrast administration, a repetition time of 24 ms, echo time of 6 ms, and section thickness of .8-1.6 mm. The scanning results were presented by reconstructing the image with maximum intensity projection. The status of posterior communicating artery was checked, and fetal posterior communicating artery pattern was excluded from analysis. We defined that present stenosis of posterior circulation included a single or bilateral vertebral artery, posterior cerebral artery, basilar artery, or subclavian artery, without ipsilateral VAH. The grade of posterior circulation stenosis (judged by a physician from the Department of Imaging) was as previously described[16]: ≤29% was defined as mild stenosis, 30%-69% was defined as moderate stenosis, and ≥70% was defined as severe stenosis or occlusion. In accordance with North American Symptomatic Carotid Endarterectomy Trial method, stenosis was calculated as follows: (normal diameter at the distal end – narrowest diameter)/normal diameter at the distal end × 100%.

Measurement of Vertebral Artery Diameter and VAH Standard

The vertebral artery diameter from segments V1 to V4 was evaluated with the AW Volume Share 5 software (GE Heathcare, USA) independently by 2 experienced deputy chief physicians in the imaging department, who measured from each MRA and CEMRA image while blind to any clinical information. A vertebral artery luminal diameter ≤2 mm, slim or absent vertebral artery to CEMRA, or a diameter ratio for the 2 vertebral arteries >1:1.7 was considered to qualify as VAH.[17]