

Differential Diagnosis of Dizziness in Patients Who Had Carotid Vertebral Artery Doppler for Arterial System Diseases

ABSTRACT

Background: Carotid vertebral Doppler ultrasonography (CVDU) is performed frequently in patients with dizziness. If a pathology is discovered, usually, it is accepted as a cause of dizziness. Our objective was to investigate the ratio of dizziness in patients tested with CVDU for arterial system diseases and make differential diagnoses of dizziness for its real cause.

Methods: A total of 195 patients undergoing CVDU were included. Among them, 20 patients reported dizziness and were referred for further examination, while the remaining 175 patients were included as controls. Advanced balance tests were performed for a differential diagnosis of dizziness. The two groups were then compared in terms of carotid narrowing, intima-media thickness (IMT), and vertebral artery resistive index (RI).

Results: Among the dizziness patients, 10 exhibited abnormal IMT, 11 showed a pathological vertebral artery resistive index, and 6 had carotid narrowing. However, when comparing the control group with the vertigo group, no significant differences were found in terms of pathological values observed in CVDU ($P > .05$). Within the vertigo group, the causes were further categorized: Ten patients had evident peripheral disease, 2 had migraine vestibulopathy, 1 had persistent postural-perceptual dizziness (3PD), 2 had orthostatic hypotension, and 1 had congenital nystagmus. One patient was considered to have vertebrobasilar insufficiency, and 3 patients were suspected to have central vascular pathology.

Conclusion: It was known that several patients who sought medical attention due to vascular disease also reported experiencing dizziness. However, it was determined that most dizziness cases were unrelated to vascular disease.

Keywords: Doppler ultrasonography, carotid, imbalance, vertebral artery, vertigo



INTRODUCTION

Balance disorders are one of the most common reasons for hospital admission.¹ Most of them have been reported to be of peripheral vestibular origin.² However, central and systemic causes are carefully evaluated for differential diagnosis. Many different test methods are widely used during this evaluation. A recent survey study determined that carotid vertebral Doppler ultrasonography (CVDU) ranks third in usage, following pure tone audiometry and magnetic resonance imaging, for patients with dizziness.³ In the same study, when the most common causes of dizziness were questioned, 22% of the subjects listed carotid vertebral artery insufficiency as the common cause. This behavior is not in accordance with the large patient series published.⁴

The carotid and vertebrobasilar arterial systems supply blood to the brain and vestibular system. Various studies have investigated the relationship between pathologies in the carotid vertebral artery system and dizziness. In a study conducted on patients with a history of coronary artery disease, imbalance, and vertigo-like complaints were observed in 41.2% of patients with 50% or more carotid stenosis.⁵ Carotid artery stenosis was also reported as 28% higher in patients with vertigo, tinnitus, and hearing loss than in the normal population.⁶ Furthermore, the thickening of the intima-media layer in the carotid artery was associated with dizziness in young people.⁷ However, the high rates reported in

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these studies, carotid and vertebral artery pathologies have not been listed on the top in large series of patients. The question is whether carotid-vertebral pathologies have a causal relationship with balance disorders or are coincidental factors related to age, metabolic diseases, etc.

In this study, patients who were admitted to the Cardiovascular Surgery outpatient clinic and underwent CVDU for arterial system diseases were also questioned about any history of balance symptoms. If the patient had any, they were reevaluated for differential diagnosis. We aimed to clarify the real cause of the balance disorder in this particular group of patients.

MATERIAL AND METHODS

This study was conducted prospectively in patients admitted to the Cardiovascular Surgery outpatient clinic and who underwent a CVDU due to vascular problems. A written informed consent form was obtained from all patients. Approval was obtained from the Pamukkale University Clinical Research Ethics Committee (60116787-020-28605, date: 02.03.2021). The study was registered on clinicaltrials.com.

"Balance Disorder Screening Questionnaire (15 questions)"⁸ and "Vertigo-Dizziness Imbalance Questionnaire-SS (14 questions)"^{9,10} were applied to all patients to see whether there was any balance disorder or similar symptoms. A single affirmative response was enough to refer to the ear, nose, throat (ENT) outpatient clinic for a detailed differential diagnosis. These patients formed the dizziness group. Patients who did not answer affirmatively to any of the questions were recorded as the control group.

Patients with impaired cooperation, a history of malignancy, central nervous system pathology, a neurological disease that affected balance in the past, and patients with advanced visual impairment were excluded from the study.

Doppler Ultrasonography

All CVDU measurements were conducted in a dimly lit room at room temperature, with the patient in the supine position, the head slightly hyperextended, and the patient looking to the left when measuring the right side, and vice versa when measuring the left side. In all patients, common carotid artery (CCA),

internal carotid artery (ICA), and vertebral artery (VA) Grayscale and color Doppler ultrasonography (GE Vivid S60) was performed using the GE 9L linear probe (4.0/8.0 MHz).

The intima-media thicknesses (IMT) of the right and left carotid arteries, the presence of plaque, and the vertebral artery resistive index (RI) were recorded. Resistive index in the vertebral artery is an index that shows how much resistance to flow develops. There are conflicting data among different publications on whether and how the RI changes with aging.¹¹ A mean RI value of 0.70 is considered normal.¹² An IMT value of 0.1 cm or more in the common carotid artery is considered pathological.¹³ The degree of carotid plaque stenosis was measured using the ECST (European Carotid Surgery Trial) method.¹⁴

Vestibular Differential Diagnosis

The patients referred to ENT were questioned regarding risk factors (diabetes, hypertension, migraine, trauma, hearing loss, etc.). The Vertigo Symptom Scale Short Form (scores ranging from 0 to 60, 60 is the worst condition)¹⁵ and Dizziness Handicap Inventory Screening Form (DHI-S) (score ranging from 0 to 40, 40 is the worst condition)¹⁶ were applied to patients. DHI-S was chosen as it was equal to the original version.¹⁷

A detailed balance examination (Head Impulse test, Romberg test, Dix-Halpike test, and Roll test), advanced balance tests (pure tone audiometry, speech discrimination score, videonystagmography) (caloric test, optokinetic test, saccadic test, tracking test, positional tests) (Chartr VNG, ICS Medical, Schaumburg, IL, USA), posturography (Biodex Balance System, Biodex Medical Systems Inc., New York, NY, USA), and video head impulse test (VHIT) ICS Impulse (GN Otometrics; Taastrup, Denmark) were then performed. Differential diagnoses were made to the patients according to the Bárány Society Classification Committee (CCBS) criteria based on anamnesis characteristics, physical examination, vestibular tests, and imaging.¹⁸ Since the causes of central vertigo in patients in whom peripheral vertigo is not considered are usually vascular pathologies and stroke, hospital records were checked to see if the patients had brain MRI, CT angiography, and MRI angiography. In patients with dizziness who were not considered to have peripheral causes but had carotid and vertebral artery pathology and no other explanation, the cause of dizziness was attributed to vascular pathology. It was an exclusion diagnosis.

Statistics

Statistical analyses were performed using the SPSS (Statistical Package for the Social Sciences), version 16.0, program. The results were compared with Pearson's chi-square test. The significance level was accepted as $P < 0.05$.

RESULTS

The study included 195 patients admitted to the Cardiovascular Surgery outpatient clinic with prediagnoses of coronary artery disease, peripheral artery disease, and carotid stenosis, all of whom underwent CVDU. Of these, 130 patients were men, and 65 were women. Twenty (10%) of these patients (13 men and 7 women) were referred to the ENT because they answered affirmatively to at least one of the screening questions. One hundred seventy-five patients (117 men and 58 women) without balance disorder and vertigo complaints were recorded as the control

MAIN POINTS

- Numerous reports say imbalance and vertigo-like complaints are frequent in patients with carotid-vertebral artery system problems. These reports make practitioners easily accept this situation as a final diagnosis if some pathology is found with CVDU, especially in older patients.
- We evaluated these patients further to make a differential diagnosis. We found dizziness due to vascular pathology only in 4/20 patients.
- Common causes of dizziness are also frequent in this group. Further questioning and testing are necessary to find the exact reason in patients with vascular disease, even if they have pathology in CVDU.

Table 1. Distribution of Abnormal Doppler Ultrasonography Findings in Patient Groups

		Dizziness		Sum	Sig.
		No	Yes		
The presence of 50% or more plaque in the carotid	No	143 (82%)	14 (70%)	157 (80%)	<i>P</i> > .05
	Yes	32 (18%)	6 (30%)	38 (20%)	
High IMT	No	79 (45%)	10 (50%)	89 (45%)	<i>P</i> > .05
	Yes	96 (55%)	10 (50%)	106 (55%)	
High RI	No	77 (44%)	9 (45%)	86 (44%)	<i>P</i> > .05
	Yes	98 (56%)	11 (55%)	109 (56%)	
Total number of pathologic findings in Doppler (total number of all above pathologies in 1 patient)	0	36 (21%)	5 (25%)	41 (21%)	
	1	62 (25%)	6 (30%)	68 (35%)	<i>P</i> > .05
	2	67 (38%)	6 (30%)	73 (37%)	<i>P</i> > .05
	3	10 (6%)	3 (15%)	13 (7%)	<i>P</i> > .05
			175 (90%)	20 (10%)	195 (100%)

There is no statistically significant relationship between dizziness and vascular pathologies.
IMT, intima media thickness; RI, resistive index.

group. The mean age of all patients was 62.84 ± 12.26 . The mean age of dizziness and control groups were 61.75 ± 13.86 and 62.97 ± 12.1 , respectively. Doppler ultrasonography results are summarized according to groups in Table 1.

If carotid artery stenosis, high IMT, and pathological RI values were combined, it was observed that the probability of dizziness increased with the increasing number of pathologies in 1 patient. However, the 2 groups had no statistically significant difference ($P > 0.05$).

The detailed examination and the final diagnosis of the 20 patients referred to ENT are summarized in Table 2. Four of them did not have advanced balance tests. The diagnosis of these patients was finalized by anamnesis and physical examination.

Vascular pathology was diagnosed as the primary cause of the balance disorder in only 4 out of the 20 patients (20%). It was 2% of the study population. Among these, 3 patients were suspected to have central vascular pathology. One patient had total occlusion of the right carotid artery on CT angiography. Additionally, two patients had a history of cerebrovascular disease, and a diffusion-restricting area in the cerebellar region was observed in brain MRIs. Notably, one of these patients had atrial fibrillation.

One patient was considered to have vertebrobasilar insufficiency. In the patient's brain CT angiography report, the left vertebral artery was evaluated as hypoplastic and poorly filling, and the basilar artery was in thin calibration.

Among the patients, 10 had evident peripheral disease. Two had migraine vestibulopathy, 1 had 3PD, 2 had orthostatic hypotension, and 1 had congenital nystagmus. A summary of all findings is shown in Figure 1.

DISCUSSION

Carotid vertebral Doppler ultrasonography is frequently performed in patients with complaints of vertigo. In this study, we selected the cohort of patients admitted to Cardiovascular Surgery due to vascular pathologies. We aimed to investigate

the relationship between dizziness and vascular pathology. It was observed that only 20 of the 195 patients had balance complaints (10%). In only 4 of 20 patients, dizziness was observed to be of vascular origin. This shows that dizziness in 2% of patients with vascular disease may be of vascular origin.

The vascular system that feeds the vestibulocochlear system cannot be directly visualized. For this reason, the vestibular system can be evaluated considering the pathologies in other vascular systems. Carotid vertebral Doppler ultrasonography is a common, inexpensive, and noninvasive imaging modality used to evaluate the carotid and vertebral arterial system. A previous study on coronary artery patients reported symptoms such as vertigo and dizziness in 21 of 51 patients with severe carotid stenosis (50% or more).⁵ After further examination of this particular study, the symptoms were described as "general," including vertigo, dizziness, lipothymia, etc. (not well defined). They did not use standardized measurements for dizziness, such as DHI. The prevalence of patients with dizziness with severe carotid stenosis could be overestimated.

According to Szirmai et al, vestibulocochlear system dysfunction was mainly associated with vascular pathologies and related ischemia in patients with vascular risk factors when other causes were excluded. In the same study, 57.9% of patients with central and peripheral vertigo had pathology in CVDU (atherosclerotic plaque in the carotid in 10 patients, occlusion in the vertebral artery in 1 patient).¹⁹ In our study, 6 out of 38 patients with 50% or more plaque in the carotid artery complained of an imbalance. Two of these six patients had vestibular weakness, one had benign paroxysmal positional vertigo (BPPV), and one had 3PD.

Intima-media thickness in the carotid arteries is a visual indicator of atherosclerosis in vascular structures.^{20,21} Similarly to atherosclerosis in the coronary arteries and IMT, a relationship can be established between atherosclerosis in the intracranial vessels and IMT.⁷ For this reason, high IMT may be a criterion in diagnosing atherosclerosis in the vertebrobasilar system and possible ischemia-related insufficiency. An IMT value of 0.1 cm or more in the common carotid artery is considered pathological.¹³ Vestibular insufficiency was observed in 2 of 10 patients with high IMT in this study. For this reason, it is impossible to talk about

Table 2. Clinical Findings of Patients with Dizziness

Patient (Age, Gender)	Doppler USG	VNG	VHIT	VSS-SS	DHI-S	Diagnosis	Risk Factors
65, M	L carotid IMT ↗	L vestibular weakness 25%	N	10	6	L unilateral vestibular weakness	Myocardial disease, hypertension, hearing loss
34, F	R RI ↗	R vestibular weakness 49%	N	9	2	R unilateral vestibular weakness	Hypertension, motion sickness
77, M	R carotid 50% plaque R carotid IMT ↗ L carotid 70% plaque	L vestibular weakness 70%	LLC	10	4	L unilateral vestibular weakness + BPPV	Heart disease
42, F	L RI ↗	N	N	11	2	BPPV	Motion sickness
56, M	R carotid total occlusion	N	N	15	4	Central vertigo due to vascular origin	Diabetes, myocardial disease, hypertension, motion sickness
48, F	N	N	N	10	2	Migraine vestibulopathy + 3PD	Migraine, psychiatric disease, sleep medicine, antidepressant use, hypertension, rheumatism
61, M	R RI ↗	N	N	6	0	BPPV	Diabetes, hypertension
67, F	R carotid 50% plaque L RI ↗	N	N	23	26	3PD	Diabetes, heart disease, sleep medicine, antidepressant use, osteoporosis, hearing loss
68, M	L and R RI ↗ L and R IMT ↗	N	N	6	0	Central vertigo due to vascular origin	Arrhythmia, anemia, hypertension, hearing loss
70, F	L and R RI ↗	N	N	24	30	BPPV	Cervical problems, hypertension, psychiatric disease, osteoporosis, motion sickness
62, M	L RI ↗ L IMT ↗	N	N	8	0	Orthostatic hypotension	Diabetes, anemia
80, M	L and R RI ↗ R IMT ↗	N	N	3	0	BPPV	Heart disease, hypertension, osteoporosis
52, F	N	N	N	27	14	Migraine vestibulopathy	Migraine, neck hernia, anemia, psychiatric disease, motion sickness, visual impairment
27, M	N	–	–	22	20	BPPV	Diabetes, cervical problems, polyneuropathy, antidepressants
77, F	R carotid 50% plaque L carotid 70% plaque R and L IMT ↗ R RI ↗	–	–	13	12	Vertebrobasilar insufficiency	Diabetes, migraine, hypertension, hearing loss, osteoporosis
66, F	R carotid 70% plaque L carotid 30% plaque R and L IMT ↗	L vestibular weakness 25%	N	2	0	BPPV	Anemia, hypertension, osteoporosis
59, M	N	N	N	25	10	Central vertigo due to vascular origin	Diabetes, hypertension, cerebrovascular disease
73, M	N	R vestibular weakness 30%	–	8	0	BPPV	Hearing loss, osteoporosis, sleep medicine
62, M	R and L IMT ↗	–	–	22	28	Congenital nystagmus	Diabetes, heart disease, anemia, hypertension, head and neck trauma
72, M	L carotid 90% plaque R IMT ↗ R RI ↗	–	–	8	4	Orthostatic hypotension	GIS cancer, anemia

3PD, persistent postural perceptible dizziness; BPPV, benign positional paroxysmal vertigo; DHI-S, dizziness handicap inventory, screening version; GIS, gastrointestinal system; IMT, intima-media thickness; L, left; N, normal; R, right; RI, resistive index; USG, ultrasonography; VHIT, video head impulse test; VNG, videonystagmography; VSS-SV, vertigo symptom scale, short version.

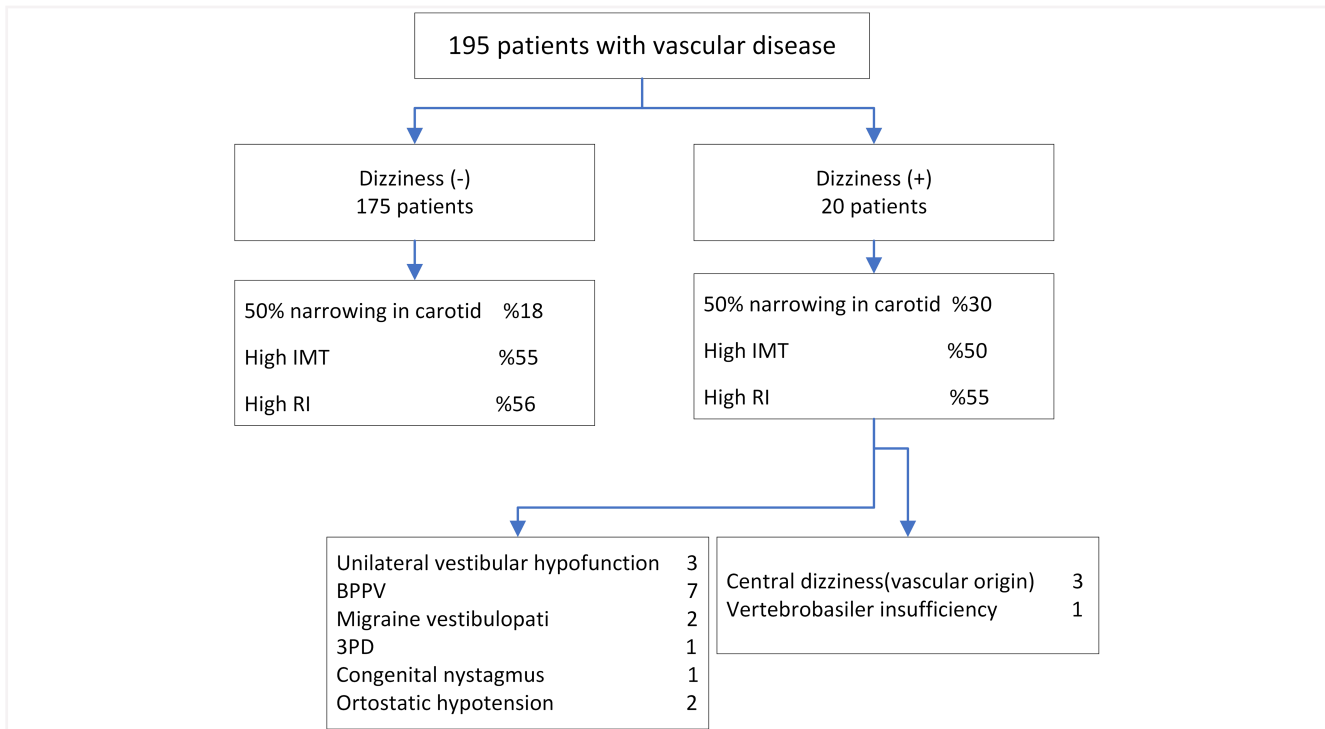


Figure 1. Summary of the patients. IMT, intima–media thickness; RI, resistive index; BPPV, benign positional paroxysmal vertigo; 3PD, persistent postural perceptible dizziness.

a direct relationship between high IMT values and vestibular system pathologies. Studies with large patient series are needed to explain the connection.

Of the 109 patients whose RI value was considered pathological, 11 complained of imbalance. Statistically, no significant correlation was found between a high RI value and the presence of vertigo. Similarly to our study, Salvaggio et al compared the RI values of patients with and without dizziness. They also found no statistically significant difference between the mean RI values of the 2 groups.⁷

Bakalarz et al reported the characteristics of patients with vertebral artery hypoplasia and significant vertebral artery asymmetry. They found vertigo symptoms in 27% of hypoplasia and 11% of asymmetric vertebral artery patients, and compared with a control group (16%), they found no statistical difference between the groups.²² They did not mention whether the vertigo symptom was alone or with other neurological symptoms.

Dorobitz et al conducted detailed vestibular tests in 63 patients with cranial artery stenosis. They found abnormalities such as spontaneous nystagmus, positional nystagmus, and defective optokinetic, tracking, and postural sway tests pointing to central pathology.²³ They also reported a positive history of vertigo in 71.4% of the patients and had worse posturographic test results than those without vertigo. They commented that abnormalities in electronystagmography and posturographic examinations in patients with cranial artery stenosis do not always manifest themselves clinically. They focused on the technical vestibular

tests but did not mention the clinical differential diagnosis of the patients.

To our knowledge, patients admitted to cardiovascular diagnosis were evaluated in detail from the vestibular clinic point of view for the first time in the literature. Therefore, accurate differential diagnoses could be made in a significant proportion of the patients. This is the most crucial advantage of the study over the existing literature.

In this study, we observed that patients with dizziness had many risk factors. It is difficult to say to what extent all these risk factors contribute to the complaint of vertigo. This is one of the limitations of the study. If the relationship between peripheral and central vascular diseases is evaluated with more parameters, such as computed tomography, magnetic resonance angiography, and digital subtraction angiography, a more accurate conclusion about the etiology of dizziness will be reached.

The CVDU in patients with vascular disease did not produce significant results in differentiating patients with dizziness. Common causes of dizziness are also frequent in this group. Further questioning and testing are necessary to find the exact reason in patients with vascular disease, even if they have pathology in CVDU.

Registration: The study was registered on clinicaltrials.com (NCT05196685).

Ethics Committee Approval: The approval was granted by the Pamukkale University Clinical Research Ethics Committee (E-60116787-020-28605, date: 02.03.2021).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

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