



Vertebral artery testing and differential diagnosis in dizzy patients

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Abstract

The vertebral artery test (VAT) is often used during the physical therapy examination but its validity as a clinical test of arterial patency is a topic of debate. When examining patients with dizziness, a modified VAT (mVAT) is routinely used to minimize angular changes of the ear limiting stimulation of the vestibular system. The mVAT can be helpful in the differential diagnostic process as dizziness can result from pathologies including vertebrobasilar insufficiency and vestibular disorders such as benign paroxysmal positional vertigo. The purpose of this paper was to review the debate surrounding the VAT and to propose using the mVAT as a test of cervical positional tolerance versus vertebral artery patency when examining dizzy patients.

Keywords: Dizziness, vertebral artery test, vestibular rehabilitation, benign paroxysmal positional vertigo, physical therapy

Introduction

Dizziness is one of the most common reasons for seeking medical consultation in the United States, particularly in older adults [1-5]. Vestibular rehabilitation is an important intervention for managing dizzy patients in the profession of physical therapy and is governed by the Neurology Section of the American Physical Therapy Association [6].

One of the challenges facing clinicians is the differential diagnostic aspect of managing dizzy patients. Dizziness can result from many origins including viral or bacterial infection, head trauma, central nervous system disease, orthostatic hypotension, psychological conditions, migraine disorders, pharmacological agents, cervicogenic dizziness or headaches, and vestibulogenic disorders [7]. Vestibulogenic disorders such as benign paroxysmal positional vertigo (BPPV) frequently cause dizziness; however, other medical conditions such as vertebrobasilar insufficiency (VBI) can also cause dizziness [7-15]. VBI is an uncommon but serious medical condition caused by a disruption in the vertebrobasilar arterial system [16-18].

Examination and evaluation of dizzy patients requires the clinician to distinguish between competing causes of dizziness, including VBI and BPPV. For example, dizziness resulting from BPPV typically presents with a characteristic torsional-jerk nystagmus while nystagmus may not be present in patients with VBI [19-21]. Also, dizziness originating from cervical arterial disorders has a slower onset compared to vestibulogenic disorders and usually presents after prolonged cervical positioning [22]. Oostendorp [23] reported a latency period of approximately 55 seconds after assuming a cervical extension-rotation position for patients with suspected VBI.

The vertebral artery test (VAT) is commonly used to screen for VBI before performing high velocity thrust (HVT) and non-HVT techniques [4,7,12,24,25]. When examining patients with suspected BPPV, a non-HVT technique called the Hallpike-Dix test is performed [4,7,12,26]. Because the ending positions of the Hallpike-Dix test and VAT are similar, and both conditions cause dizziness, differential diagnosis is necessary. A modified VAT (mVAT) has been described in the literature to assist in the differential diagnostic process of dizzy patients and is performed in sitting versus supine [13].

The VAT, and subsequently the mVAT, continues to be a topic of considerable debate given the inconsistent reporting of their validity as clinical tests for vertebral artery patency [8,9,15,24,25,27]. The purpose of this paper was to review the debate surrounding the VAT and to propose using the mVAT as a test of cervical positional tolerance versus arterial patency when examining dizzy patients.

Vertebral artery anatomical considerations

The vertebral arteries ascend superiorly through the transverse foramen of C6-C1 before coursing horizontally around the posterior arch of the atlas where they enter the foramen magnum and merge with one another to form the basilar artery [4,8,12,15]. The basilar artery ultimately gives rise to the circle of Willis providing cortical perfusion [15]. Vertebral artery blood flow can be diminished through a reduced cross-sectional area of the arterial lumen as they navigate through and around the bony and soft tissue structures of the upper and lower cervical spine [8,15]. Duan et al., [28] reported that the bony structure of the craniocervical junction and upper cervical spine is

variable in people. Utilizing three-dimensional images they identified five curves in the vertebral artery pathway. These curves have unexpected variations in size and shape and are further compounded in older adults. Hong et al., [29] utilized computerized tomography angiographical analysis to investigate the anatomical variations of the vertebral artery segment in the lower cervical spine. They identified atypical entrances of the vertebral artery from the transverse process above C6, adding further complexity to the vertebral artery route. A reduction in brainstem perfusion can lead to symptoms consistent with VBI, especially in individuals whose collateral circulatory system cannot make up for reduced blood supply [30-32]. Also, external compressive forces may result from muscular tightness surrounding the arteries or bony abnormalities along the vertebral artery pathway [15]. Additionally, atherosclerosis or thromboemboli can directly impede arterial blood flow leading to VBI [15,26].

Vertebral artery testing

Theoretically, the VAT assesses collateral blood supply to the brain while purposively compromising the vertebral artery circulation [27]. Cervical spine active range of motion is usually performed before passive assessment [9,27]. Next, the patient lies supine and their cervical spine is taken into passive extension, lateral flexion, and ipsilateral rotation [14]. The clinician maintains each position for 10-30 seconds while observing for symptoms consistent with VBI and the test is repeated on both sides [14]. Symptom provocation in any of the positions is considered a positive test [14]. Organizations including the Australian Physiotherapy Association (APA), Manipulation Association of Chartered Physiotherapists (MACP), and Society of Orthopaedic Medicine (SOM) have issued specific protocols for the cervical spine before applying HVT techniques [9,27]. These organizations agree that if the VAT is positive, cervical spine HVT techniques should not be performed and is considered a contraindication [9,25]. The APA, MACP, SOM protocols include subjective questions that can help detect patients with a higher possibility of VBI before using the VAT [9,25]. When a patient reports avoidance of end-range neck positions as a result of fear, this may be indicative of higher probability of VBI [33,34].

The VAT and mVAT provide the clinician with bedside clinical measures of cervical positional tolerance prior to performing cervical spine manipulation or the Hallpike-Dix test. Because the ending position of the head and neck are similar with the Hallpike-Dix test and VAT, the mVAT can be used to help in the differential diagnostic process. The mVAT minimizes angular position changes of the inner ear and dizziness attributed to BPPV is less likely to be provoked [13]. As described by Clendaniel and Landel [13], the mVAT is performed with the patient seated as the clinician draws the patient forward from the head to create neck extension. There are no angular changes in the head during this procedure and therefore, minimal disruption of the vertical semicircular

canals occurs. While maintaining the neck extension, the examiner then guides the patient's neck into rotation and ipsilateral lateral flexion to each side. Again, angular changes to the vertical semicircular canals occurs and it is this minimal angular displacement that distinguishes the mVAT from the traditional VAT. Each of these three positions is maintained for 10-30 seconds as the examiner observes for symptoms consistent with VBI [13].

Validity of the vertebral artery test

According to DiFabio [16], there is not enough evidence in the literature to support symptom aggravation as a valid assessment to rule out VBI. Given the lack of evidence supporting available tests and measures, clinicians cannot definitively rule out VBI [24]. Cote et al., [35] conducted a study using Doppler ultrasonography to quantify vascular impedance on 42 participants in the VAT extension-rotation position. They determined the predictive values for sensitivity and positivity of the VAT as zero. Mitchell et al., [8] tested this theory, which is the VAT maximally rotated cervical spine positions, in a study of 30 participants. They utilized transcranial Doppler sonography in order to identify significant reduction in intracranial vertebral artery blood flow while the cervical spine was sustained in end range rotation to the left and later to the right and comparing it to the neutral position. Furthermore, Mitchell et al., [8] suggest there are study design flaws in blood flow analyses not finding noteworthy blood flow reduction in the VAT position. In particular, very little research has been conducted to measure blood flow distal to the location where the restriction is thought to happen [8]. In another study, Mitchell [36] demonstrated that sustained end-range rotation is the most reliable and provocative examination. Cervical spine rotation during the VAT appears to have the largest impact on blood flow. Mann and Refshaug [37] reported that in 16 out of 20 Doppler studies, diminished blood flow was observed in the contra-lateral vertebral artery during cervical rotation with or without extension.

Differential diagnosis

When assessing the dizzy patient, proper decision-making process requires the clinician to perform an efficient and purposeful patient examination. Critical aspects of the history include tempo (subjective measure of symptom onset), circumstances (activities producing or exacerbating symptoms), and the specific symptoms or type of dizziness [7]. Schubert [12] reported that dizziness is usually categorized into one of four different sub-types: vertigo (pure sensation of rotation or spinning); lightheadedness (feeling faint); oscillopsia (visual environment disturbance); and disequilibrium (inability to maintain body balance). Additionally, the clinician should consider other causes of dizziness such as head injury, orthostatic hypotension, bacterial and viral infection, psychological problems, pharmacological contributions, cervicogenic and vestibular disorders, neurological diseases,

and VBI [7,12,13,38-42]. Once the history is complete, the clinician can move forward with hypothesis formulation and selection of appropriate tests and measures.

Because VBI is on the clinician's hypothetical list of possible causes of dizziness, the mVAT is performed as part of a screening examination. A point of enduring contention in the literature, as stated previously, is the validity of the VAT [8,9,15,24,25,27]. During the VAT, the vertebral artery on the opposite side slides forward and down causing it to narrow due to bony and fixed surrounding structures and prevention of VBI symptoms is dependent upon a sufficient collateral vascular supply [43-49].

The risk of an adverse reaction resulting from VBI following cervical spine HVT technique is small occurring in 1:20,000 persons [50]. To the author's knowledge, adverse reactions resulting from VBI following the non-HVT Hallpike-Dix test have not been reported. The current controversy of the VAT is its questionable validity for evaluating VBI [15,16,24,25]. According to Vidal [15], the primary factors driving the VAT controversy as a valid test in neck circulation patency include anatomical variations in the vertebrobasilar arterial pathway, orthopedic and biomechanical cervical spine considerations, consideration of the past medical history, cerebral blood supply redundancy and variances in clinical interventions. The Guide to Physical Therapist Practice [51] encourages physical therapists to examine patients using valid and reliable tests. Because the physical therapy profession is gaining national direct access status in many states, valid and reliable tests are becoming more important in the decision-making process [15,16,25]. Unfortunately, there is not a valid or reliable test for examining potential VBI during the decision-making process [15,16,25]. The Guide to Physical Therapist Practice [23] promotes physical therapists usage of available tests and measures that are lacking validity and reliability if there is not an existing alternative. As a result, the VAT is utilized by many physical therapists to screen for VBI [13,14,25,27].

A systematic review by Hutting et al., [52] determined that it wasn't possible to draw firm conclusions about the diagnostic accuracy of the VAT. Using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS), the authors reported that "of the 1677 potential citations only 4 studies were included, all of questionable quality".

In addition to the absence of high quality studies, another layer of complexity is the variable VAT and mVAT outcomes reported by clinicians including false negatives, true positives, and false positives.

Terenzi [53] reported a case of a 28 year-old female complaining of symptoms consistent with VBI. The VAT was negative but transcranial Doppler and *magnetic resonance angiography* (MRA) revealed abnormal vascular patency, thus, a false negative VAT because of collateral compensation for the vertebral arterial stenosis.

Similarly, Rivet et al., [49] reported a case of a 20 year-old male patient with neck pain and frontal headaches. Pre-

manipulative testing guidelines were performed as per the APA recommendations and the VAT was negative. Subsequently, a combination of mobilization and HVT techniques were performed. After treatment, the patient agreed to participate in a study that utilized diagnostic ultrasound. Surprisingly, the results revealed a complete arterial reflection causing occlusion in the left vertebral artery. The authors attributed the absence of a positive VAT to sufficient collateral circulation.

Asavasopon et al., [54] reported a case of a 63-year-old female whose symptoms were consistent with VBI. The VAT was positive and the patient was referred to a physician for further diagnostic testing. The ultrasonography and MRA revealed stenosis in the left carotid artery and the patient underwent an endarterectomy. This case report showed a true-positive finding and appropriate patient management that reduced patient risk for possible adverse reactions if cervical manipulation had been performed.

Johnson et al., [55] reported a case of a 24 year old female with a positive mVAT who was referred for further diagnostic imaging. Ultrasound Doppler duplex testing revealed normal bilateral anterograde blood flow in both vertebral and carotid arteries. The patient was referred back to physical therapy by the physician with a diagnosis of exclusion concerning suspicion of VBI. Subsequent physical examination was performed revealing upper cervical musculature tightness including the upper trapezius, levator scapulae, sternocleidomastoid, and anterior scalene muscles. The physical therapist intervened using manual therapy to restore normal cervical spine muscle length. The mVAT was performed immediately following the manual therapy intervention and it was negative and remained resolved during follow-up sessions conducted over several months. The authors theorized that the symptoms were due to arterial mechanical deformation due to cervical muscle tightness and not true VBI.

Conclusion

The VAT has not been consistently validated as a clinical test for VBI. Nevertheless, many clinicians utilize the VAT in the absence of an alternative test. When clinicians suspect VBI during the subjective examination they should refer the patient for further medical diagnostic testing. Since a valid and reliable physical therapy screening test for VBI does not presently exist, the authors recommend using the VAT to assess the cervical positional tolerance. When this test is positive, the patient should be referred for further diagnostic tests to rule out VBI. In the case of managing dizzy patients, VBI and vestibular disorders have dizziness as a common symptom. As mentioned previously, the mVAT provides the clinician an objective assessment regarding cervical positional tolerance with minimal disruption of the vestibular system. The Hallpike-Dix test does not require end-range cervical spine rotation; conversely the mVAT places more compressive force on the cervical arterial structures. A negative mVAT accompanied by a positive Hallpike-Dix test implicates vestibulogenic dizziness

and the clinician can proceed with the proper intervention. It is the opinion of the authors that at the very least, both the VAT and mVAT provide the clinician with bedside clinical measures of cervical positional tolerance prior to performing cervical spine manipulation or the Hallpike-Dix test. In the presence of a positive VAT or mVAT, the clinician cannot report with any degree of certainty the integrity of vertebral artery patency. In this instance, the clinician should proceed cautiously and further physical therapy management should not be performed without further medical evaluation.

List of abbreviations

VAT: Vertebral artery test
 mVAT: Modified vertebral artery test
 BPPV: Benign paroxysmal positional vertigo
 VBI: Vertebrobasilar insufficiency
 HVT: High velocity thrust
 APA: Australian Physiotherapy Association
 MACP: Manipulation Association of Chartered Physiotherapists
 SOM: Society of Orthopaedic Medicine
 MRA: Magnetic resonance angiography
 QUADAS: Quality Assessment of Diagnostic Accuracy Studies

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	AA	EGJ	TKC
Research concept and design	--	✓	--
Collection and/or assembly of data	✓	✓	✓
Data analysis and interpretation	--	--	--
Writing the article	✓	✓	✓
Critical revision of the article	✓	✓	✓
Final approval of article	✓	✓	✓
Statistical analysis	--	--	--

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