



Low scores on the Benton Facial Recognition Test associated with vertebrobasilar insufficiency

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ABSTRACT

Background: Decreased posterior cerebral circulation has been observed in patients with vertebrobasilar insufficiency (VBI). Reduced cerebral perfusion may have an impact on mental performance as measured by the Benton Facial Recognition Test (BFRT). We evaluated the usefulness of BFRT in identifying cognitive decline in patients with VBI by correlating test performance with total blood flow in the vertebrobasilar system and other variables such as educational level and gender.

Materials and methods: Thirty-three participants without dementia (mini-mental state examination; MMSE >27) and cranial magnetic resonance imaging abnormality, but with atherosclerotic risk factors were involved in the study. Nineteen subjects had a total vertebrobasilar flow volume less than 200 ml/min (Group I), and 14 subjects had a flow volume more than 200 ml/min (Group II).

Results: The groups were similar in regard to gender, age, and educational level. BFRT results were 19.53 ± 3.12 and 22.36 ± 2.73 for Groups I and II, respectively ($p = 0.01$). The educational level was the main factor affecting the BFRT score in Group I ($p = 0.04$).

Discussion: BFRT is clearly impaired in VBI as measured by Doppler ultrasound examination. We concluded that the test appears to adequately distinguish cognitive levels between VBI and other patients. Additionally, our results suggest that education is associated with BFRT results, and for normative purposes, gender consideration is unnecessary. Further studies are needed to investigate the association between VBI and memory dysfunction in early dementia.

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Introduction

The posterior circulation of the brain includes the vertebral arteries, the basilar artery, and the posterior cerebral arteries and their branches [1,2]. These arteries, through short penetrating branches and circumferential branches, supply the brainstem (medulla, pons, and midbrain), thalamus, hippocampus, cerebellum, and parts of the occipital and temporal lobes (including the visual cortex). The arterial anatomy of the posterior circulation varies markedly [1,2]. Vertebrobasilar insufficiency (VBI) is characterised by fluctuating brainstem symptoms, such as dizziness, and is associated with cranial nerve symptoms or cerebellar dysfunction over a period of days to weeks. VBI indicates insufficient blood flow through the posterior circulation and is essentially a brainstem transient ischemic attack (TIA). Rarely, VBI will present as vertigo

alone [3,4]. Bendick et al. proposed an arbitrary threshold of 200 mL/min for net vertebral artery (VA) flow volume using the conventional duplex sonographic method and suggested that patients with lower flow volumes were at risk for vertebrobasilar ischemia [5]. Seidel et al. [6] reported similar values for older people and suggested that a net VA flow volume of less than 100 mL/min should be considered an indication of low VA flow.

The visual unimodal area is a large cortical region comprising areas 18 and 19 that sends multiple projections to the primary visual cortex. The posterior area of the right hemisphere is associated with visuospatial ability, which is important for facial recognition [7,8]. Furthermore, evidence suggests that the cerebellum is activated by various cognitive tasks [9,10]. Early studies of cognitive deficits in patients with cerebellar lesions reported that visuospatial ability was impaired following cerebellar damage [10,11]. Molinari et al. [10] focused on visuospatial performance in subjects with cerebellar damage and reported that cerebellar disorders were not strictly associated with motor symptoms but had significant effects on cognitive ability, including visuospatial skills. The posterior area of the right hemisphere is related to visuospatial

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ability in facial recognition [8]. Abnormalities in facial recognition result from occipital lobe lesions near the parietal and temporal lobes [7]. The inability to recognise well-known and unknown faces are two types of visual agnosia [7,8,12,13]. Individuals must possess intact consciousness, normal cognition, and language function to be evaluated for visual agnosia. In a recent study, Tippett et al. [12] reported that visuospatial performance was clearly impaired in mild Alzheimer's disease and was correlated with functional deficits, as indicated by the cerebral perfusion ratios obtained from single photon emission computerised tomography (SPECT) findings. Therefore, we hypothesised that the Benton Facial Recognition Test (BFRT) could be used to examine gnosis of unknown faces and predict dementia development [13,14]. Additionally, reduced cerebral perfusion was considered to affect mental performance, and a correlation between BFRT performance and total blood flow measurement could therefore be predicted.

Materials and methods

Patient characteristics

Fifty-two participants who were clinically suspected to have VBI owing to symptoms such as position-dependent vertigo, diplopia, gait disturbance, and drop attacks were examined. Exclusion criteria were a history of psychiatric, neurological, or cardiovascular disorders or of substance abuse or dependence (including alcohol and benzodiazepine abuse) or a history of head injury or any other medical condition (including significant visual impairments not sufficiently corrected by visual aids) that might affect neuropsychological performance. All participants were native Turkish speakers. We further excluded older adults (more than 70 years old) who obtained scores of less than 27 on initial testing with the Turkish validated version of the Mini Mental State Examination (MMSE) [15], a brief screening measure for global cognitive deficits. After evaluation, 33 patients were included in the present study, which was conducted at the Neurological Clinic of Düzce University Hospital.

The patients were examined using Doppler sonography. Net VA flow volume was measured by calculating the sum of right and left VA flow volumes. The patients were divided into two groups according to VA flow volume: Group I ($n = 19$) consisted of patients with moderately damped VA flow volume (<200 mL/min), and Group II ($n = 14$) consisted of patients with normal VA flow volume (≥ 200 mL/min) used as the control group. Patients were then tested for gnosis of unknown faces using the BFRT. Informed consent was obtained from each participant, and the study was approved by the Local Ethics Committee of the University of Düzce Medical School.

Doppler sonography examinations

Doppler sonography examinations were performed in a dimly lit room at a comfortable temperature (22–24 °C) following an adaptation period of at least 15 min of rest in the supine position. To avoid interobserver variance, all right and left VA measurements were performed by the same radiologist using the same Doppler ultra sonography device (Hitachi EUB 5500, Japan) with a standard 7 MHz linear transducer. The patient's head was turned slightly to the opposite side of the VA being examined. Flow volume measurements were generally taken in the C4 and C5 inter-transverse segment of the VA. The complete examination took about 15 min for each patient.

BFRT assessment

All patients were tested individually by the same neurologist at the Neurological Clinic of Düzce University. They were first given

the MMSE, and the BFRT was then administered. We used the BFRT short form developed by Levin and standardised in Turkish by Keskinliç et al. [14,16]. The BFRT short form with 27 possible points was presented, with a target face above six stimulus faces that were centred within a black background. For the first six trials, only one of the six stimulus faces was identical to the target face. In the next seven trials, three of the stimulus faces matched the target. Patients were given at least 15 min with 13 unknown faces requiring 27 responses.

Statistical analysis

Pearson correlation analysis was used to test the effect of aging, gender, and educational level on VA flow volume. The group mean systolic flow velocities were compared using Student's *t*-test. The effect of education on BFRT scores were evaluated by the ANOVA test. A *chi*-square test was used to test for sex differences. All parametric results are expressed as mean \pm *SD*. A *p*-value < 0.05 was deemed to be statistically significant.

Results

There were no significant differences between the two groups in gender, age, and educational level (Table 1). The mean blood flow results for Groups I and II were 139.21 ± 36.52 and 312.71 ± 69.38 mL/min, respectively, as shown in Table 1. The mean BFRT scores for Groups I and II were 19.53 ± 3.12 and 22.36 ± 2.73 , respectively ($p = 0.01$; Table 1). Educational level was positively associated with BFRT scores in Group I ($p = 0.04$). ANOVA showed that people who graduated from primary school differed from people who graduated from high school or university ($p = 0.05$ and 0.02 , respectively). Only one person graduated from a university among the VBI patients, and there was a significant difference in BFRT results between patients who graduated from primary school and high school (*t*-test, $p = 0.048$). However, when only the patients were analysed, there was no significant correlation between BFRT scores and educational level ($p = 0.06$).

Discussion

In the present study, the BFRT scores of VBI patients were lower than those of controls. The BFRT was shown to detect early changes related to visuospatial skills, which may be helpful during follow-up regarding cognitive functions of VBI patients. These results were expected because VBI is mainly a disease of elderly people, similar to dementia syndromes. The diagnosis of VBI is clinical, and the cause is usually atherosclerosis of posterior circulation. VBI patients may suffer from episodes of transient global amnesia and a step-wise deterioration of memory and higher cortical

Table 1
Comparison of socio-demographic variables, ultrasound, and clinical findings in the two groups.

Variables	Group I	Group II (Control)	<i>p</i> -Value*
Age (years)	49.79 \pm 11.36	49.4 \pm 9.48	0.92
Gender			
Male	6	6	0.71
Female	13	8	
Educational level			0.08
Primary school	11	10	
High school	7	3	
University	1	1	
BFRT score	19.53 \pm 3.12	22.36 \pm 2.73	0.01
Total VA volume (ml/min)	139.21 \pm 36.52	312.71 \pm 69.38	0.00

* Chi-square test, Student's *t*-test.

functions [17]. Amnesia is a late complication of VBI because the terminal branches of the vertebrobasilar system supply areas of the diencephalon, para-amygdaloid areas, and other areas of the temporal and occipital lobes concerned with important intellectual functions, particularly recent memory and visuospatial functioning [18–20]. Perez et al. also confirmed that patients with VBI performed slightly below average on most cognitive measures when their scores were corrected for age [21]. As discussed in the introductory section, the posterior area of the right hemisphere and cerebellum is associated with visuospatial ability, which is important for facial recognition [9–13]. Previous studies reported that low scores on the BFRT were associated with damage to the right inferior posterior parietal region (specifically in the angular gyrus) extending into the lateral superior occipital gyri and with damage to the mesial inferior occipitotemporal region in the area of the fusiform gyrus [7,8]. In other words, the patients with right-hemisphere damage performed more poorly on facial recognition tasks than did patients with left-hemisphere damage or healthy control subjects [7,8,12,13]. Our study did not include patients with lesions (infarction or sequel to haemorrhage); therefore, there was no lesion or hemisphere localisation, and discussion regarding a damaged side of the brain was not possible. As mentioned above, VBI causes decreased posterior cerebral circulation and cognitive decline. Typically, other transient signs are of primary interest, and cognitive decline is not necessarily apparent in daily life. Our study showed that VBI patients require more care in follow-up.

Poor cognitive performance is strongly associated with other stroke risk factors [22,23] and with cerebral microvascular disease [24]. VBI is a risk factor for stroke and pre-existing vascular pathology. The BFRT may be sensitive to progressive neurodegenerative brain disorders that are primarily characterised by memory disturbances and common acute neurological conditions such as stroke [22–24]. The mean score on the BFRT has been reported to be the most effective means of discriminating between patients with dementia and normal older controls [25,26]. In agreement with previous study results, we found a decline in the test performance of VBI patients having a higher risk of stroke despite the fact that they did not have brain lesions. This finding was also important because lower BFRT scores were found in the patients without any parenchymal lesions in the present study, indicating that decreased blood flow may be a risk factor for dementia.

Age, education, and IQ are associated with visual gnosis, and these variables should be considered when interpreting performance on the BFRT [22]. Furthermore, it has been suggested that sex differences are not associated with visual gnosis [22,26]. The sociodemographic characteristics of patients in our groups were similar (Table 1). Educational level was positively associated with BFRT scores in both groups, a result that is consistent with studies showing similar associations between high educational level and high BFRT scores [22]. However, the difference was significant only in Group II and was so small that it should not be construed as affecting our study results. Our finding that increasing age was not correlated with lower BFRT scores is not consistent with previous reports [22,27,28]. Several studies have suggested that age-related changes do not occur until after 50 years of age and/or that they accelerate after 70 years of age [28,29]. The mean age of our patients was 49.64 ± 10.45 years (range: 31–70 years), and our results supported the presence of two age ranges (30s and 70s) in which the relationship between BFRT scores and cognitive changes was noteworthy.

In summary, the BFRT results were clearly reduced in patients with VBI. Collectively, our results also suggest that educational level is positively associated with scores on the BFRT, and this relationship is not gender-specific. Further studies are needed to investigate the association between VBI and memory dysfunction

during early stages of dementia. Confirmation of our findings with larger and more diverse samples is necessary before the present findings can be generalised.

Conflict of interest

None.

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