PATHOLOGICAL FINDING OF AUDITORY EVOKED POTENTIALS IN PATIENTS WITH VERTEBRAL ARTERY HYPOPLASIA ASSOCIATED WITH POSTERIOR CIRCULATION STROKE

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Abstract: The aim of the paper was to determine clinical significance of pathological finding and characteristics of auditory evoked potentials (AEP) in patients with posterior circulation stroke caused by vertebral artery hypoplasia (VAH). The study enrolled 71 patients, 31 of them had posterior circulation stroke. The results of the examinations showed that pathological AEP finding was statistically significantly correlated with posterior circulation stroke (PCS) finding. Changes in AEP amplitude presented a prominent feature of stroke caused by vertebral artery hypoplasia and require further clinical investigations.

Key words: VAH, VA, PCS, AEP

1.Introduction

The vertebral artery (VA) is the first lateral branch of the subclavian artery. It is rarely a direct branch arising from the aortic arch. Considering the long course of this artery from its origin, it can be divided into 4 topographic divisions: pars prevertebralis, pars cervicalis, pars atlantica and pars intracranialis (1).

Only ¼ of the population have both vertebral arteries of the same caliber.

In general population the VAs are commonly asymmetric in caliber. In about 50% of cases the left vertebral artery lumen is wider, whereas the diameter of the right VA is less commonly larger (25%) (1). Besides these physiological differences in diameter, one of the potential pathological changes on vertebral artery is vertebral artery hypoplasia (VAH). This entity is an uncommon congenital anomaly of blood vessels (2,3). There is a lack of agreement in defining VAH. The current definition means the diameter is equal or less than 2mm, and up to 3mm in some studies (3).

Additionally, VAH definition should be complemented with hemodynamic parameters as well, assessed by Colour Doppler sonography (CDS). Thus, there is reduced blood flow velocity in VAH, systolic velocity less than 40cm/sec, and increased resistance index value (IR)>0.75. Some studies define a clear distinction in the reduction of blood flow in the group of patients with hypoplasia, with VA flow volume of81.6 ± 16.5ml/min, whereas it was 123± 13,5ml/min in the group without VAH (4). Apart from the aforementioned, more common domination of physiological asymmetry of the left VA caliber, right-sided VAH is twice as common as left-sided VAH. (4,5).

VAH results in chronic vascular insufficiency of vertebrobasilar arterial territory and, apart from well known risk factors (age, hypertension, cardiac diseases …), it may also be a risk factor of posterior circulation stroke-PCS. Although PCS is primarily diagnosed by clinical and radiological assessment, useful data and information on determining lesion location may be obtained by electrophysiology, especially by auditory evoked potentials (AEP), being an important predictor of final outcome assessment (6). AEP is an electrophysiological method that has normally been utilized to diagnose pathological changes of the brainstem (7).

Considering the fact that each AEP wave is generated within the brainstem vascularized by posterior circulation arteries (VA and its branches), this method adds relevant information for diagnostics and localization of lesions in the brainstem (8). Special significance of AEP in diagnostic process is also due to the fact that this method is a clinically reliable one, independent of iatrogenic complications of medications: barbiturates and anaesthetics (9).

2. Aims of the paper

1. Investigate the significance of AEP in diagnostics of posterior circulation stroke
2. Determine clinical relevance and potential positive correlation between AEP pathological finding in patients with VAH and posterior circulation stroke.

3. Determine the features of AEP findings in patients with posterior circulation stroke caused by VAH.

3. Patients and methods

This study is a prospective one, enrolling 71 patients. Out of them, 31 patients were in the experimental group, with posterior circulation stroke. The control group included 40 patients with nonvascular etiologic changes in the brainstem. All the patients underwent Computed Tomography (CT) of the brain, which revealed PCS. In cases of small lesions in the brainstem undetectable by CT, magnetic resonance imaging (MRI) of the brain was performed. Carotid arteries colour Doppler imaging was performed in all the patients using Esaote MyLab 70 apparatus, linear probe of 4-11MHz, with pulse repetition frequency PRF of 1-1.8 kHz. The insonation of the V2 segment of vertebral artery was performed in two adjacent intervertebral spaces. Apart from other common parameters (systolic and diastolic velocity, resistance index RI), blood vessel diameter was also measured. The diagnosis of VAH by using the ultrasound with Doppler was specified by the VA diameter of 2mm or less. In patients with suspected VAH observed on Doppler ultrasound, it was verified by computed tomography angiography (CTA), or magnetic resonance angiography (MRA).

All the patients from both groups underwent AEP monitoring on Nihon Kohden's Neuropack M1device, with time base of 10ms, frequency of 5 stimuli per second, a total of 2048 stimuli. A specific type of signal (alternate click of 70dB above hearing threshold) stimulated auditory nerve and the response generated along the auditory pathway and registered at certain points of the scalp by silver disc electrodes was monitored. Active electrodes were placed on the mastoids (A1,A2), reference electrode on the vertex, and ground electrodes on the forehead. In this way both peripheral and central portion of the auditory pathway can be assessed, since seven negative waves within 10ms after stimulation with different amplitude and latency (analyzed later) and interwave latency as well (I-III, III-V, I-V interwave intervals) were obtained as a response to the stimulus. Pathological finding is defined by diminished amplitude of waves (50% less than normal values), poorly formed waves, absence of some waves, as well as prolonged absolute latencies of certain waves and also prolonged inter-wave latencies, IWL. The reference values of all the parameters have already been established as a standard within our institution.

All the obtained results are statistically analyzed and presented in tabular form. Upon admission to the department, patients signed an informed consent for the required therapeutic and diagnostic procedures.

4. Results

Table 1 AEP finding in patients of both experimental and control group

AEP finding	Experimental group	%	Control group	%
Normal	7	22.51 %	33	82.5%
Pathological	24	77.49 %	7	17.5%
Total	31	100 %	40	100 %

The presence of pathological AEP finding is statistically significantly more common in patients with PCS. Chi square is 25.5;$p < 0.01$.

Table 2 Distribution of AEP findings in patients of experimental and control group in relation to the presence and absence of VAH

AEP finding	Experimental group with VAH	Experimental group without VAH	Control group with VAH	Control group without VAH	Total
Normal	3 (23.07%)	4 (22.22%)	2 (50 %)	31 (86.5 %)	40 (56.3%)
Pathological	10 (76.9 %)	14 (77.77%)	2 (50%)	5 (13.88%)	31 (43.6%)
Total	13 (100%)	18 (100 %)	4 (100%)	36 (100%)	71 (100 %)

Statistically significant difference of AEP pathological results between experimental and control group has not been found in relation to the presence of VAH. Chi square was 1.06; $P > 0.05$.

Table 3 Distribution of single, individual characteristics of AEP in patents of experimental and control group in relation to the presence or absence of VAH

AEP finding	Experimental group with VAH	Experimental group without VAH	Control group with VAH	Control group without VAH
Normal finding	3 (23.07%)	4 (22.22%)	2 (50%)	31 (86.1 %)
IWL	2 (15.38%)	4 (22.22 %)	0	1 (2.7 %)
Amplitude	4 (30.76%)	1(5.5 %)	0	1 (2.7 %)
Poorly formed wave	1 (7.69%)	3(16.5%)	0	1 (2.7 %)
Peripheral disorders	1 (7.69%)	1 (5.5 %)	0	0
Retrocochlear lesion	0	1 (5.5 %)	2 (50 %)	2 (5.5 %)
Multiple associated changes	2 (15.38 %)	4 (22.22 %)	0	0
Total	13 (100 %)	18 (100%)	4 (100 %)	36 (100 %)

Changes in the amplitude as an individual characteristic of AEP were statistically significantly observed in patients with VAH in experimental group in comparison to the patients with stroke, but without VAH. Chi square was 7.9; p< 0.01

5. Discussion

VAH is an uncommon congenital anomaly of the VA that results in chronic vascular insufficiency of the posterior circulation of the brain (10). The significance of AEP as an electrophysiological method in diagnosing ischemic changes accompanied with posterior circulation lesions can be found in literature data (11).

The results of our study confirmed that patients with PCS, as the most severe stage of vascular insufficiency, have statistically significantly more common AEP pathological finding (77.49%) in comparison to nonvascular lesions of the subjects in the control group (17.55). This difference is statistically significant. (Chi square was25.5;p<0.01).(Table 1)

Vertebral artery hypoplasia as a separate etiological factor for PCS onset is presented in Table 2. The highest percentage of VAH findings was recorded in the experimental group of patients, 41.93% of them in comparison to the controls (10%).

The relevance of AEP in diagnosing vascular lesions of the brainstem and for lesion site localization originates from the assumption that damage within a region of the brain, being a generator of AEP waves, results in morphological changes, as well as in changes of other characteristics of AEP findings.

Besides a cerebral infarction as the most severe form of posterior circulation ischemia, the significance of AEP in diagnosing transitory ischemic attacks (TIA) has also been described in literature. Usually, TIA patients experience both regression of the disease and improvements of AEPs and clinical manifestation as well. In cases of repeated episodes of TIA (chronic VB insufficiency), permanent changes in AEP analysis have been described. Poorly formed waves, with changes in amplitude (more than 50% drop in amplitude), have been described as a special characteristic of AEP in chronic vertebrobasilar (VB) insufficiency (12).

The results of our study shown in Table 2 illustrate that the percentage of pathological AEP findings was higher in experimental group with VAH in comparison to the controls with VAH (77.9%:50%), but this difference is not statistically significant. Chi square is 1.06;p>0.05.

Table 3 presents characteristics of AEP findings in patients with and without VAH in both experimental and control groups and wave amplitude only was found to be statistically significant. Patients with posterior circulation ischemia associated with VAH had statistically significantly higher percentage of changes in amplitude (30.76%) in comparison to ischemic patients without VAH (5.5%). This difference is statistically significant. Chi square =7.9;p < 0.01.

Similar results related to the relevance of changes in amplitude and waveforms, which are characteristics of AEP in chronic VB insufficiency, have been described by other authors as well (13).

Characteristics of AEP in brainstem infarction, but without distinguishing VAH as an etiological factor, were registered by Wang H in his study. This author identifies prolonged latency of waves III and IV as the most important characteristic of AEP findings in patients with PCS(14).

In one of the papers describing potential complications of stenting of the VA it is pointed

out that patients who experienced PCS during this intervention had prolonged IWL of waves I-V in AEP findings (15).

These changes in aforementioned waves have also been noted by other authors who analyzed AEP findings in patients with basilar artery dolichoectasia and subsequent presence of lacunar infarctions in the posterior circulation (16).

Thorwirth et al described absence of wave III in patients with lesion in pons (17).

Apart from already described changes in amplitude and IWL, changes in absolute latencies of the waves in patients with PCS have been reported in some studies (Drake et al) (18).

5. Conclusion

Pathological AEP finding in patients with VAH has great diagnostic and prognostic value, since it is statistically significantly associated with severe stages of ischemia, that is, with posterior circulation stroke. Alternations in wave amplitude, characteristic of AEP, have been identified as a statistically most significant parameter associated with posterior circulation stroke and concomitant VAH. Further studies,with a larger number of patients are needed, to investigate clinical relevance of AEP findings in patients with ischemic lesions associated with VAH

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