PATTERN SHIFT VISUAL EVOKED RESPONSE

APPLICATION IN NEUROLOGY

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An evoked response (ER) or evoked potential (EP) is an electrical response of the brain to a visual, auditory or somatosensory stimulus. The transient electrical event recorded at the scalp in response to a visual stimulus of shifting pattern of squares is named pattern shift visual evoked response (PSVER).

The PSVER has been studied in a large group or normal controls and patients with neurologic diseases. With the development of more stable stimulation techniques, powerful amplifiers and computers able to sum and average the evoked potentials and exclude the background noise (EEG, muscle artifacts) the ER became clinically useful.

The long latency components of the ER, appearing more than 75 milliseconds (msec) after stimulation has a relatively large amplitude (5-50 microvolts) and varies with many psychological parameters, such as attention and state of consciousness. However, the PSVER is the long latency response with the highest degree of wave form consistency and stability.

We discuss the PSVER, a non-invasive clinical test, emphasizing the basic procedure, the normal responses, the pathophysiology, the abnormal findings, the indications and the value of the test.

TECHNICAL CONSIDERATIONS

The patient sits one meter from a TV monitor and fixates on a small dot in the center of the screen where an alternating checkerboard pattern of black and white squares is seen. The patient wears his usual glasses. Each eye is tested separately, with a patch placed over the opposite eye. Scalp electrodes are placed in the occipital region at O_1, O_z and O_2 (international 10-20 system) with a vertex reference (CZ). Linked ears are used as an alternative reference. Electrodes are attached to the scalp with collodion and electrolytic paste is used to maintain impedances below 5000 ohms.

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Acknowledgement: This paper was partially supported by funds of Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP).

Routinely the low linear frequency filter is set at 1 Hertz (Hz) and the high frequency filter at 100 Hz. The whole screen subtends 16 degrees of visual angle and each individual square 6.88' of arc (or 3.44' when smaller sized stimuli are used). A total of 200 msec is average over 128 trials for each check size and for each eye. The averaging process is displayed on an oscilloscope to monitor artifacts and the final result is recorded with an X-Y plotter. The whole procedure takes about 30-40 minutes.

RESULTS AND INTERPRETATION

The PSVER has a prominent major down going (positive) wave with a peak at approximately 100 msec latency, called the P100 or P2 (case 1 — figure 1). Smaller components (P1, N1, and N2) are usually present but are not considered clinically important. It is assumed that the P100 is generated by neurons of the primary occipital cortex (area 17). Normative data for each laboratory is mandatory 18.

The 21 controls in our laboratory showed a fiirst positive wave mean ($\bar{x}$) of 104.50 msec $\pm$ a standard deviation (SD) of 5.02. The intereye difference for latency should be less than 8.5 msec ($\bar{x}$) $+$ 3 SD).

Several factors may affect the latency and amplitude of P100 and they have to be taken into consideration: age, level of arousal, pattern luminance, pattern contrast, EEG amplifier filters, stimulation rate and type of stimulation 6.18.

The test presumes an absence of ocular pathology anterior to the optic nerve and retina. Visual acuity does not seriously affect P100 latency until it reaches 20/200 or worse (when the patient can not see the checkerboard). The P100 amplitude, however, is more closely related to visual acuity.

The abnormal responses primarily related to latency and are defined as greater than 3.0 SD. We do not consider amplitude criteria, unless there is no measurable peak.

Once ocular pathology is excluded, the delay in latency of PSVER is a reliable index of a disturbance in the optic pathway.

CASES FOR ILLUSTRATION

Case 1 — Normal control (Fig. 1).

Case 2 — A 55 year old female with a three year history of progressive gait disturbance and two years of urgency and incontinence of the bladder and bowel. No visual or other complaints above the neck. Neurologic examination revealed normal cranial nerves with normal fundi, no nystagmus, positive Romberg's sign, moderately severe cerebellar intention tremor of the four extremities, no definitive weakness, increased tonus in the legs, deep tendon reflexes 3+/5, ankle clonus, Babinski's sign bilaterally, decreased vibration sense up to the clavicals and decreased joint position sense at the big toes. Cerebrospinal fluid (CSF): 46mg% of gamma globulin and 4 white cells. CT-scan showed a mild degree of cortical and cerebellar atrophy. In this

case the PSVER (Fig. 2) was very important in confirming the diagnosis of multiple sclerosis (MS).

Case 3 — A 70 year old male with a nine month history of progressive stocking and glove sensory neuropathy. The work up revealed intrinsic factor and B 12 deficiency and pernicious anemia. There were no visual complaints PSVER is shown in figure 3.

DISCUSSION

Shahrokhi et al. [17] described an abnormal PSVER in 36% of 87 MS patients who had no history or evidence of optic nerve involvement in either side. PSVER is specially important in patients with possible or probable MS (by the criteria of McAlpine, Lumder & Acheson [15]), but without visual complaints.

Chiappa [5] found abnormal PSVERs in patients with clinically unsuspected lesions in the visual system in 20% of the possible MS group and 41% of the probable MS group. He concluded that the test revealed unsuspected lesions better than CT-scan and as good as the CSF gamma globulin. Asselman et al. [1] found abnormal PSVERs in 84%, 83% and 21% of patients with definite, probable and possible MS respectively. 47% of the abnormal PSVER patients had no history of optic neuropathy (ON).

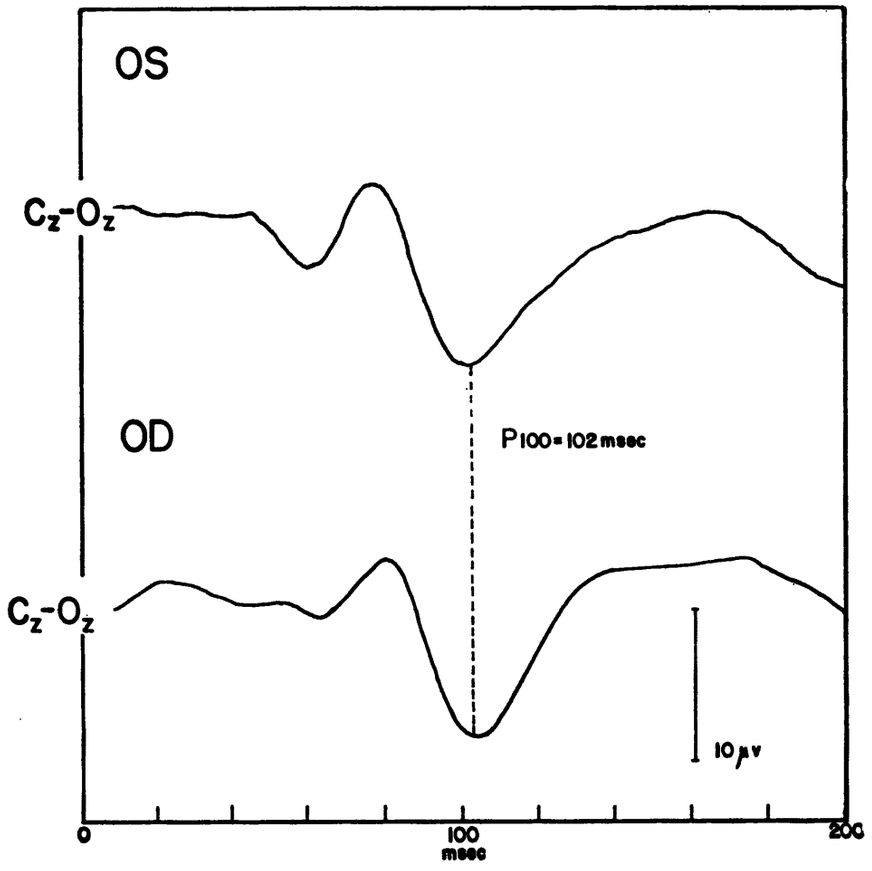

Fig. 1 — Normal 17 year old control: OS = Left eye stimulation; OD = Right eye stimulation.

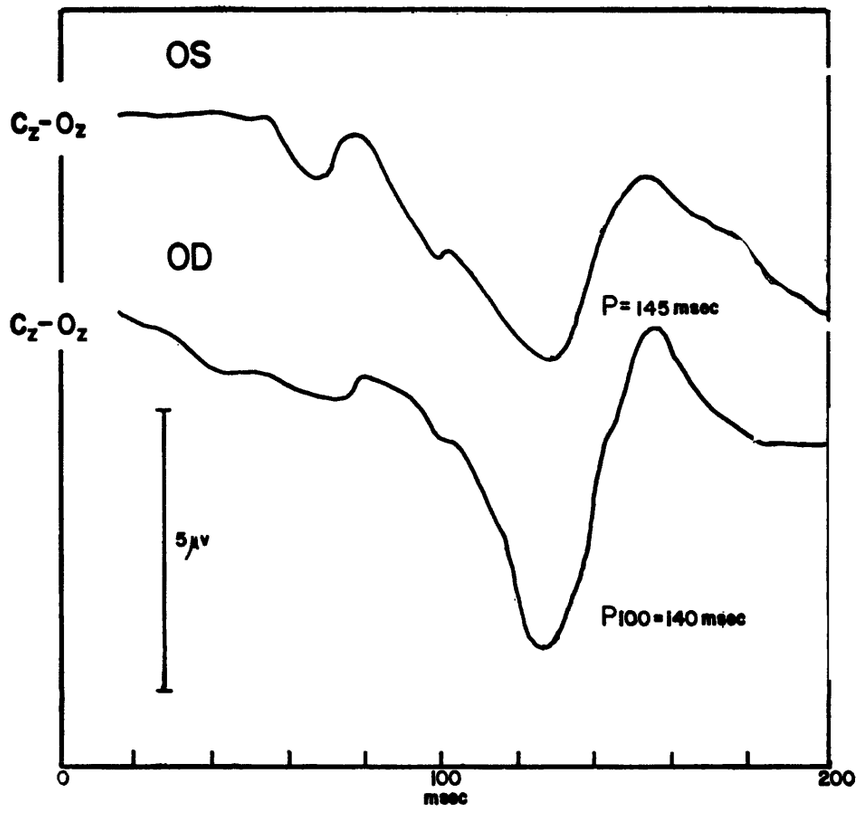

Fig. 2 — MS patient without visual complaints. Note the delay and asymmetry of P100 latency.

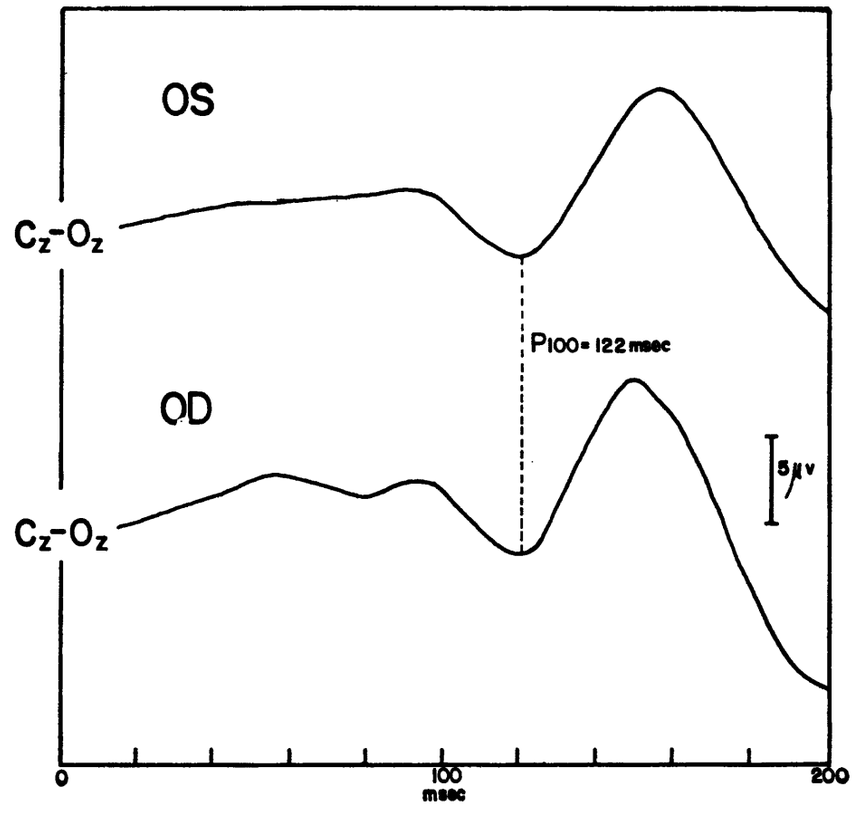

Fig. 3 — B12 deficiency peripheral neuropathy patient. There were no visual signs or complaints. Note the mild bilateral and symmetrical delay in P100 latency.

It must be emphasized that an abnormal PSVER does not always mean demyelination in the optic nerve, although that is the most common cause of it. Compressive lesions of the anterior visual pathways [8,10] and diseases anterior to the retina (glaucoma) [17] must be ruled out.

Bilateral but synmetrical delay in conduction is non-localizing. Pathology could be located at any point between retina and occipital cortex.

Sklar et al. [19] using flash VEP reported abnormal values in a pilot study in patients with hydrocephalus. Results on follow-up correlated well with improvement in the post-shunt period.

Several other conditions have been noted to cause abnormal PSVERs, such as pernicious anemia [21], ischemic optic neuropathy [1,22], alcohol-tobacco amblyopia [11], Jakob-Creutzfeldt's disease [16], subacute sclerosing panencephalitis [16], adrenoleucodystrophy [14], Parkinson's disease [2], Friedreich's ataxia [3,13], and hereditary spastic ataxia [13]. Two basic pathologies of peripheral nerve fibers are focal segmental demyelination and axonal loss. In the former, axonal transmission across the area of demyelination is preserved but at a slower velocity. A good example of this is seen in MS with ON. In cases with axonal loss, axonal transmission is interrupted and no conduction of nerve impulses is possible (conduction block). Ischemic optic neuropathy [22] is an example of axonal loss.

PSVER is a very sensitive and reliable diagnostic test in the investigation of lesions of the anterior visual pathways [1,8], but there is controversy about its use of localizing retrochiasmatic lesons. Halliday et al. [9] described amplitude attenuation in the occipital region ipsilateral to the visual field deficit while Asselman et al.[1] could not detect most retrochiasmatic lesions. Streletz et al. [20] claimed a positive correlation between unilateral occipital lobe lesions, homonymous visual field loss and PSVER abnormalities. Kuroiwa & Celesia [12] described a more complex approach with two different VEPs (transient and steady-state) and hemifield stimulation. However, they concluded that neither test has yet proved as sensitive as field perimetry for a retrochiasmatic lesion.

At the moment the best indications for PSVER are: 1) to exclude an asymptomatic lesion in the visual system, or 2) to document a presumed lesion and corroborate the diagnosis of MS. In hysterical blindness it may be used to demonstrate a normal conduction. It can show any involvement of the optic system in neurologic diseases, even when subclinical [1,5,7,17].

SUMMARY

The technique that we use for pattern shift visual evoked response (PSVER) is described. PSVER is a non-invasive, practical and reliable clinical test in detecting anterior visual pathways lesions even when asymptomatic. The ability to find unsuspected lesions in multiple sclerosis, making possible an early diagnosis, is underscored. We also discuss some pathophysiologic aspects and the findings of the PSVER in some neurologic disorders with visual system involvement.

RESUMO

Potencial evocado visual por padrão alternante: aplicação em Neurologia.

Potencial evocado visual por padrão alternante (PEV) é a resposta elétrica obtida pela estimulação visual através de um padrão alternante de quadrados brancos e pretos num vídeo de televisão. Isto é possível graças a um computador que realiza a promediação ("averaging") e é capaz de captar a resposta evocada no couro cabeludo e eliminar os ruidos (EEG, artefatos musculares e de movimentos).

Este teste, não invasivo, tem sido reconhecido universalmente como um método prático, confiável e muito sensível na detecção de patologia do sistema visual anterior ao quiasma ótico. Normalmente uma onda positiva ao redor de 100 msec (P100) é registrada. Presume-se que este potencial seja originado em neurônios no córtex occipital primário (área 17). O principal parâmetro de anormalidade é a latência deste potencial P100. A acuidade visual não se relaciona com a latência de P100 mas sim com a amplitude.

Excluída patologia do globo ocular (degeneração retiniana e glaucoma), assimetria de latência do potencial P100, estatísticamente significante para os valores normais do laboratório, indica lesão do nervo óptico do lado envolvido. A causa mais comum do retardo do potencial P100 é doença desmielinizante. Com o PEV é possível fazer-se o diagnóstico precoce de esclerose múltipla (EM) mesmo em pacientes que não apresentam queixas visuais. Uma lesão compressiva do nervo óptico pode simular a anormalidade das doenças desmielinizantes, ainda que o grau do retardo do potencial P100 seja, em geral, menor. Com características diversas da EM, principalmente com relação à simetria do comprometimento da latência e da amplitude do potencial P100, tem-se descrito PEV anormal nas seguintes entidades nosológicas: anemi perniciosa, neuropatia óptica isquêmica, ambliopia por tabaco-álcool, doença de Jakob-Creutzfeldt, adrenoleucodistrofia, panencefalite esclerosante subaguda, doença de Parkinson e degenerações espino-cerebelares.

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