Retinal Symmetry of Multifocal Visual Evoked Potential in Both Eyes of Normal Subjects

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Purpose: To analyze the retinal symmetry of multifocal visual evoked potential (mfVEP) in both eyes of normal subjects.

Methods: The monocular mfVEP in both eyes of 36 normal subjects (72 eyes) were tested with VERIS Science 4.0. The stimulus was the pattern reversal dart array consisted of 60 sectors each including 16 black-white reverse patterns. The visual stimulation was controlled by a binary pseudo-random m-sequence and subtended 25 degrees of retinal region.

Results: The mfVEP patterns between left and right eyes of each subject were similar, and P_1 latency and amplitude in correspondent visual field quadrants between left and right eyes had no significant difference ($P>0.05$). The latency of superotemporal visual field quadrant in right eyes was shorter than that of superonasal visual field quadrant in left eyes, and the amplitude of superonasal visual field quadrant in right eyes was longer than that of superotemporal visual field quadrant in left eyes ($P<0.05$). The P_1 latency and amplitude among four visual field quadrants of each eye had significant difference ($P<0.05$). The P_1 latency between the superonasal visual field quadrant and inferotemporal visual field quadrant or between the superonasal visual field quadrant and inferonasal quadrant visual field had significant differences in right or left eyes ($P<0.05$).

Conclusion: The mfVEP of normal subjects exists retinal symmetry. ***Eye Science 2010; 25: 72-76.***

Key words: Symmetry; Multifocal visual evoked potential; Normal subject

Multifocal visual evoked potential (mfVEP) records cortical response signals originated from retina. It can be acquired by one or more electrodes with the reverse of stimulated pattern controlled by the binary pseudo-freedom series.

As we all know, after images being projected to retina, the signals from temporal retina were conducted to the ipsilateral visual cortex, but the signals from nasal retina was conducted to the contralateral visual cortex. The visual evoked potential (VEP) was produced in both sides of visual cortex when only one eye was stimulated. The stimulation from the same

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area of visual field, such as the temporal visual field of the right eye or the nasal visual field of the left eye, may produce potentials at the left visual cortex same side of.If the right eye and the left eye were tested separately, stimulation to the temporal visual field of right eye and the nasal visual field of left eye both can produce similar VEP at the left visual cortex.The same situation will also appear in the right visual cortex.Otherwise, stimulation from the correspondent visual field, such as the nasal visual field in right eye and that in left eye, will produce VEP signals in different sides of the visual cortex. In normal subjects, we may expect that VEP in the right cortex which comes from the nasal visual field of the right eye and the VEP in the left cortex that comes from the nasal visual field of the left eye may be also similar. These facts make confusion in explaining mfVEP.

The purpose of this study was to clarify the symmetry of mfVEP in bilateral eyes of normal subjects.

Subjects and Methods

1 Subjects

Thirty-six normal subjects (72 eyes) including 21 males (42 eyes) and 15 females (30 eyes) were enrolled in this study.Their ages were 18 to 64 years-old (median age of 34 years-old) and their visual acuities were 1.0 (20/20) or better.They had clear refracting media and normal intra-ocular tension.Subjects with history of eye or general diseases were excluded.

2 Methods

The monocular mfVEP was recorded separately with VERIS Science 4.0. The stimulus was the pattern reversal dart array consisting of 60 sectors each including 16 black-white reverse patterns which were controlled by pseudo-random binary m-sequences and subtended 25 degrees of visual field.The luminance of each sector alternated between white and black. The length of the m-sequence was 2^{14}-1. The stimulus was presented on a high-resolution 21 inches black-white monitor with a frame rate of 75 Hz at a distance of 32 cm from the subjects' eyes.The maximal and minimal brightness of the screen were 200 cd.m^{-2} and 0.3 cd.m^{-2} respectively. The contrast of the white and black checkboard was 99.7%.

The signal was amplified 100 000 times using amplifier with 3 ~100 Hz bandpass.The sample frequency was 1 200 Hz.

The gold-disc skin electrodes were used and linked by bipolar occipital straddle (BOS) recommended by Klistorner[1]. Two recording electrodes were placed 2 cm above and blow the onion respectively.

The subjects were asked to sit comfortably before stimulatior and fixed the center of the stimulation pattern when test was proceeding. Each recording was divided into 8 equal segments and the total recording time was 3 minutes and 38 seconds.

The first slice of the second-order of mfVEP was analyzed by the software of VERIS. The waves were grouped into superonasal, superotemporal, inferonasal and inferotemporal visual field quadrants.The amplitude and latency were evaluated and indicated with average response density (nV/deg^2) and milliseconds (ms) respectively.

3 Statistical analysis

The paired *t*-test was employed to compare the difference of amplitude and latency in correspondent visual field quadrants between the bilateral eyes. The one-way *ANOVA* was em-

ployed to compare the amplitude and latency among different visual field quadrants of the right or left eyes with SPSS statistical software.

Results

The mfVEP was recorded from both eyes of all 36 normal subjects, one of which was showed in Fig 1. The waveforms of the right eye and left eye were similar. In statistics, the trace array was divided into 4 groups according to the visual field quadrants.

The mfVEP pattern between left and right eyes was similar, and P_1 latency and amplitude in correspondent visual field quadrants between left and right eyes had no significant difference (P>0.05) (Tab 1).

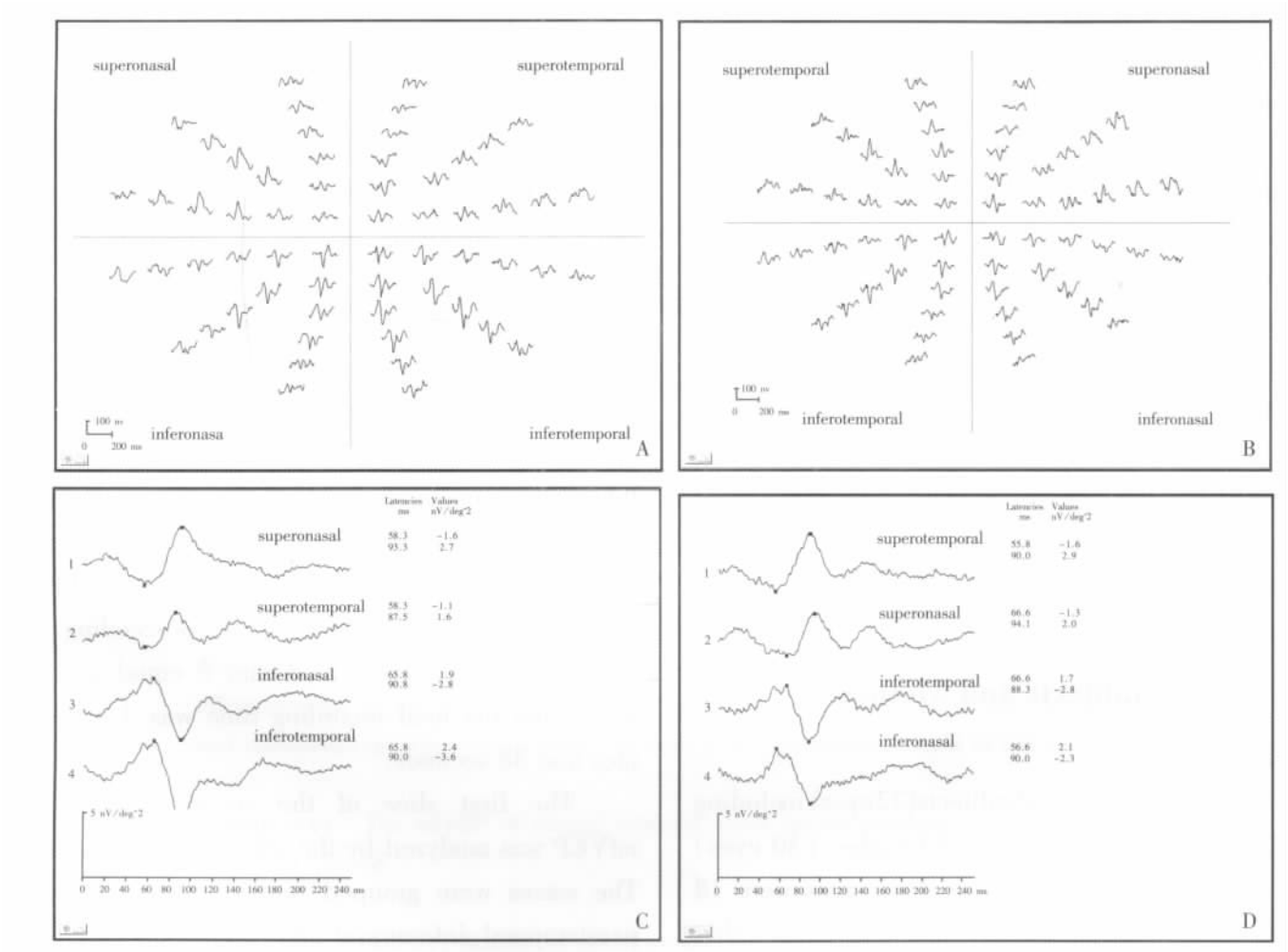

Fig 1. The mfVEP of the both eyes of a normal subject

A. The trace array of mfVEP in the four visual field quadrants of the right eye

B. The trace array of mfVEP in the four visual field quadrants of the left eye

C. The latency and amplitude in the four visual field quadrants of the right eye

D. The latency and amplitude in the four visual field quadrants of the left eye

P_1 latency and amplitude in ipsilateral visual field quadrants were compared between bilateral eyes, which showed that the latency of superotemporal visual field quadrant in one eyes was shorter than that of superonasal visual field quadrant in the other eyes, and the amplitude of superonasal visual field quadrant in one eyes was longer than that of superotemporal visual

Table1. The comparisons of P_1 latency (ms) and amplitude (nV/deg^2) in correspondent visual field quadrants between left and right eyes

	Right eyes (n=36)	Left eyes (n=36)	P
Latency			
Superotemporal	97.14±6.71	98.36±6.65	0.1924
Superonasal	100.02±6.89	100.20±7.28	0.8663
inferotemporal	95.15±7.70	94.78±5.84	0.7530
inferonasal	95.30±5.76	95.85±8.64	0.6666
Amplitude			
superotemporal	1.34±0.66	1.29±0.53	0.4670
superonasal	1.49±0.77	1.46±0.58	0.7239
inferotemporal	1.80±0.93	1.78±0.92	0.8900
inferonasal	1.82±0.90	1.68±0.93	0.1648

field quadrant in the other eyes (P<0.05) (Tab 2).

Table 2. Comparison of P_1 latency (ms) and amplitude (nV/deg^2) of ipsilateral quadrant visual fields between both eyes

	Right eyes (n=36)	Left eyes (n=36)	P Value
Latency			
RST *vs* LSN	97.14±6.71	100.21±7.28	0.0069
RSN *vs* LST	100.02±6.89	98.36±6.65	0.1243
RIT *vs* LIN	95.15±7.70	95.85±8.64	0.5946
RIN *vs* LIT	95.30±5.76	94.78±5.84	0.5578
Amplitude			
RST *vs* LSN	1.34±0.66	1.46±0.58	0.1219
RSN *vs* LST	1.49±0.77	1.29±0.53	0.0127
RIT *vs* LIN	1.80±0.93	1.68±0.93	0.1158
RIN *vs* LIT	1.82±0.90	1.78±0.92	0.6416

RST: superotemporal visual field quadrant of right eyes
RSN: superonasal visual field quadrant of right eyes
RIT: inferotemporal visual field quadrant of right eyes
RIN: inferonasal visual field quadrant of right eyes
LST: superotemporal visual field quadrant of left eyes
LSN: superonasal visual field quadrant of left eyes
LIT: inferotemporal visual field quadrant of left eyes
LIN: inferonasal visual field quadrant of left eyes

The P_1 latency and amplitude among four visual field quadrants of each eye had significant difference (P<0.05) (Tab 3). The P_1 latency between the superonasal visual field quadrant and inferotemporal visual field quadrant or between the superonasal visual field quadrant and inferonasal visual field quadrant had significant differences in right or left eyes (P<0.05) (Tab 4~5).

Table 3. ANOVA analysis for the P_1 latency (ms) and amplitude (nV/deg^2) among four visual field quadrants in right and left eyes

	Eyes	F value	P value
Right eyes			
P_1 latency	36	4.008	0.009
P_1 amplitude	36	2.971	0.034
Left eyes			
P_1 latency	36	4.213	0.007
P_1 amplitude	36	3.053	0.031

Table 4. The comparison of P_1 latency and amplitude between every two visual field quadrants in right eyes

Comparison group	P_1 latency		P_1 amplitude	
	T value.	P value	T value.	P value
RST *vs* RSN	−2.8778	0.276	−0.1444	0.879
RST *vs* RIT	1.9972	0.598	−0.4583	0.084
RST *vs* RIN	1.8472	0.657	−0.4778	0.065
RSN *vs* RIT	4.875	0.013	−0.3139	0.367
RSN *vs* RIN	4.725	0.017	−0.3333	0.313
RIT *vs* RIN	−0.1500	1.000	−0.019	1.000

Table 5. The comparison of P_1 latency and amplitude between every two visual field quadrants in left eyes

Comparison group	P_1 latency		P_1 amplitude	
	T value	P value	T value	P value
LST *vs* LSN	−1.8444	0.695	−0.1722	0.773
LST *vs* LIT	3.5889	0.146	−0.4972	0.029
LST *vs* LIN	2.5139	0.446	−0.3889	0.134
LSN *vs* LIT	5.4333	0.007	−0.3250	0.270
LSN *vs* LIN	4.3583	0.049	−0.2167	0.624
LIT *vs* LIN	−1.0750	0.920	0.1083	0.931

Discussion

Although the mfVEP of normal subjects have been reported, defined description on the mfVEP symmetry hasn't been found. A normative database for the mfVEP in 100 subjects

with normal visual fields have been described. They analyzed the influence of SNR (signal-to-noise ratio) to the mfVEP and found that there was no overall effect of age on SNR, while sex had a small but significant effect on SNR[2]. Hood[3] also considered that in testing for abnormalities in interocular latency, the confidence interval should be based upon the SNR of the response.

In an interocular comparison of the mfVEP symmetry, Hood showed that the pairs of mfVEP responses from the two eyes of 6 control subjects were essentially identical except small interocular difference in timing attributable to the difference between nasal and temporal retina. The mfVEP showed symmetrical responses between the two eyes of the normal subjects[4]. It is obvious that their method used for comparing was different from ours.Graham[5] showed that the VEP traces from both eyes of 24 control subjects were almost identical for each field location.They considered that the variation of the individual VEP recorded from different parts of the visual field was primarily determined by the underlying convolution of the striate cortex.Their method used for comparing each pair of the response was not described clearly. Our study grouped all the traces of one visual field quadrant so as to increase the SNR. From the similarity of latency and amplitude in the correspondent visual field quadrants of both eyes, we concluded that mfVEP was retinal symmetry.

In addition, the comparisons of P_1 latency and amplitude in the four quadrants of visual field of each eye also showed similar pattern, which confirmed the retinal symmetry of mfVEP.

As the extensive application of mfVEP in some patients with glaucoma[6-8] and optic neuropathies[9-13], mfVEP is considered as an objective perimetry. The study on the characteristics of mfVEP showed its important roles in the clinical application. It suggested that the retinal symmetry must be emphasized in the analysis of mfVEP when both eyes were tested at the same time.

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羊膜作为一种来源方便、取材容易和价格便宜等诸多优点的生物膜在临床上应用越来越广，如覆盖烧伤的创面、修补缺损等等。

有研究报道，羊膜培养基能显著减轻促进角膜新生血管生成的碱性成纤维细胞生长因子，其机制至少部分是在于羊膜所分泌或释放的高水平TIMP2蛋白，对血管内皮细胞的迁移和生长起到了抑制作用[3]。此外，羊膜中还含有层粘蛋白、纤维连接蛋白、Ⅳ型胶原纤维等，能刺激上皮的分化、增生，延长上皮细胞的生命，维持其克隆形成，增强上皮细胞的黏附性，是一种支持上皮生发、细胞生长的理想物质[4]。羊膜中含有各种蛋白酶，通过抑制相应的蛋白酶而发挥其清除炎症的作用[5,6]；同时羊膜能抑制转化因子的表达及信号传递，并能抑制正常成纤维细胞分化为肌成纤维细胞[7]，从而避免炎症细胞和细胞因子诱发的角膜基质和胶原纤维的过度增生。因此，在眼表重建时促进表面愈合而不留瘢痕。碱性物质因能与组织中的脂类及蛋白反应成为可溶性的蛋白化合物，能长期、稳定地存在于眼内。虽然进行了多次的结膜囊冲洗或是更直接的前房冲洗，眼内组织仍有可能受到碱性成分的损害。而羊膜中的纤维母细胞层及海绵层复水后含有大量的粘液，能起到稀释、缓冲碱的作用，因此，也能直接减少碱性物质的化学损伤。本研究发现，无论在烧伤后 14 d 还是 60 d，治疗组的角膜新生血管面积均小于对照组；结果提示，羊膜移植具有明显的抑制角膜新生血管的作用，是一种较理想的治疗早期重症眼碱烧伤的方法。

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