Increased Latency of Visual Evoked Potentials in Healthy Women during Menstruation

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Purpose: To evaluate the latency of visual evoked potentials (VEPs) in healthy women during and after menstruation.

Methods: Pattern and flash VEPs were performed in 15 healthy women aged 18 to 25 years on the maximum bleeding day (luteal phase) and 7 days after the menstrual cycle (follicular phase).

Results: Mean latency was 119.6 msec on the maximum bleeding day and 100.8 msec one week after menstruation on pattern VEP (P < 0.001). Corresponding values for flash VEP were 124.5 msec and 112.7 msec, respectively (P < 0.001).

Conclusion: Prolonged VEP latency on the maximum bleeding day indicates that high progesterone levels may have an inhibitory effect on optic nerve conduction velocity.

Keywords: Visual Evoked Potential; Menstruation; Visual Cortex

INTRODUCTION

The visual evoked potential (VEP) is an electrical signal generated by the occipital visual cortex in response to stimulation of the retina either by light flashes or pattern stimuli. In cooperative subjects, the amplitude and implicit time of pattern VEP is less variable than flash VEP. On the other hand, the amplitude of flash VEP is greater and therefore more easily recorded. Flash VEP wave form, implicit time and amplitude are strikingly variable among different patients and even within the same subject. VEP can evaluate the integrity of the visual pathway and help in the diagnosis of optic nerve disorders.\(^1\,^2\) It has been reported that technical and physiological factors such as pupil diameter, refractive error, type of stimulus, age and sex, electrode position, and anatomical variations may affect VEP.\(^3\) In this study we evaluated VEP changes during and after menstruation, i.e., in luteal (high progesterone levels) and follicular phases (high estrogen levels), respectively.

METHODS

The study included 15 healthy female volunteers with no systemic, gynecological or neurological disease. Informed consent was obtained from all participants. All subjects underwent a complete ophthalmologic examination; subjects with abnormalities in the retina or optic nerve, and those with refractive errors more than ±0.5 D were excluded.

VEP was performed in all subjects according to a standard method described by the International Society for Classification of Electrophysiology of Vision (ISCEV) using the MonElec2 system (Metrovision Inc., Pérenchies, France), on the maximum bleeding day and 7 days after cessation of menstruation, using both pattern reversal and flash light stimuli.
For pattern VEP, stimulation was performed using 30 minute of arc alternating black and white check patterns on a video monitor at one meter with the subject fixating on a central target on the monitor. Flash stimuli were produced with a full-field (Ganzfeld) xenon arc photostimulator.

RESULTS

Mean age of studied subjects was 20.7 ± 2.8 (range, 18 to 25) years. Latencies of pattern (P100) and flash (P2) VEPs were significantly higher on the maximum bleeding day in comparison with one week post-menstruation in all subjects (Table 1). Mean latency of pattern and flash stimulation decreased from 119.6 and 124.5 on the maximum bleeding day to 100.8 msec and 112.7 msec on the post-menstruation day on pattern and flash VEP, respectively (P < 0.001).

The distribution of flash and pattern VEP latencies on the maximum bleeding day and on the post menstruation day are illustrated in figures 1 and 2 respectively. Figures 3 and 4 illustrate pattern and flash VEPs in a typical

Table 1. Latency of visual evoked potentials in 15 women on maximum bleeding days and post menstruation days

| Subject | Age | Latency of PVEP (msec) | Lag of PVEP | Change (%) | Latency of FVEP (msec) | Lag of FVEP | Change (%) |
|---------|-----|-----------------------|-------------|------------|-----------------------|-------------|------------|
|         | MBD | PMD                   | Lag of PVEP |            | MBD                   | PMD         |            |
| 1       | 19  | 114                   | 97          | 17         | 119                   | 108         | 11         | 10.2 |
| 2       | 18  | 113                   | 92          | 21         | 127                   | 111         | 16         | 14.4 |
| 3       | 18  | 120                   | 98          | 22         | 132                   | 120         | 12         | 10.0 |
| 4       | 22  | 119                   | 102         | 17         | 119                   | 106         | 13         | 12.3 |
| 5       | 25  | 123                   | 103         | 20         | 124                   | 109         | 15         | 13.8 |
| 6       | 18  | 125                   | 108         | 17         | 121                   | 112         | 9          | 8.0  |
| 7       | 25  | 114                   | 96          | 18         | 118                   | 107         | 11         | 10.3 |
| 8       | 18  | 119                   | 103         | 16         | 122                   | 112         | 10         | 8.9  |
| 9       | 20  | 122                   | 104         | 18         | 119                   | 110         | 9          | 8.2  |
| 10      | 20  | 115                   | 96          | 19         | 130                   | 117         | 13         | 11.1 |
| 11      | 18  | 119                   | 97          | 22         | 121                   | 107         | 14         | 13.1 |
| 12      | 19  | 122                   | 102         | 20         | 131                   | 116         | 15         | 12.9 |
| 13      | 24  | 119                   | 102         | 17         | 122                   | 117         | 5          | 4.3  |
| 14      | 22  | 125                   | 105         | 20         | 131                   | 120         | 11         | 9.2  |
| 15      | 25  | 125                   | 107         | 18         | 132                   | 119         | 13         | 10.9 |
| Mean    | 20.7| 119.6                 | 100.8       | 18.8       | 124.5                 | 112.7       | 11.8       | 10.5 |
| SD      | 2.8 | 4.1                   | 4.6         | 1.9        | 5.4                   | 5.0         | 2.9        | 2.6  |
| Median  | 20.0| 119.0                 | 102.0       | 18.0       | 122.0                 | 112.0       | 12.0       | 10.3 |
| Minimum | 18.0| 113.0                 | 92.0        | 16.0       | 118.0                 | 106.0       | 5.0        | 4.3  |
| Maximum | 25.0| 125.0                 | 108.0       | 22.0       | 132.0                 | 120.0       | 16.0       | 14.4 |

95% CI for change: PVEP, pattern visual evoked potential; MBD, maximum bleeding day; PMD, post-menstruation day; FVEP, flash visual evoked potential; SD, standard deviation; CI, confidence interval
case on post-menstruation day and on maximum bleeding day, respectively.

DISCUSSION

VEP is an evoked electrophysiological potential which can be extracted using signal averaging from electroencephalographic activity recorded at the scalp. Increased latency on VEP waves is the hallmark of many visual pathway diseases. There are different studies on VEP changes in healthy females during the menstrual cycle. Studying 23 healthy female subjects with regular menstruation, Kaneda et al. showed increased latency on flash VEPs associated with low estrogen and high progesterone levels. Shushtarian et al. also reported prolongation of flash VEP latency in 20 female subjects during a normal cycle. Furthermore, estrogen has been shown to shorten VEP latency in animals.8,9 Vingerling et al. reported an association between macular degeneration and early menopause.11 The effect of estrogen on the central nervous system seems to be antagonized by progesterone and its metabolites, therefore prolonged VEP latency is thought to reflect the effect of progesterone.8,10,12

In our series, menstruation was associated with increased pattern and flash VEP latencies in 15 healthy women aged 18 to 25 years. The most probable reasons for increased VEP latency during menstruation may be as follows: (1) decrease in blood estrogen levels and diminution of the neuroprotective effect of estrogen; (2) associated biochemical changes causing anxiety and stress, thus interfering with concentration on the central target of the monitor; (3) vascular congestion around the optic nerve reducing conduction velocity.12,15

In conclusion, prolongation of VEP latency during the menstrual cycle in the luteal phase probably reflects the effect of progesterone. This effect is more notable on pattern as compared to flash VEP. The clinical implication of these findings is in the application of VEP for confirming demyelinating disease and optic neuritis. In such cases one should take into account that prolongation of VEP latency during menstruation may erroneously verify demyelinating disease.

Figure 2. Distribution of latencies of pattern visual evoked potentials on maximum bleeding day and on post-menstruation day.

Figure 3. Latency of pattern visual evoked potential on post-menstruation day (A) and maximum bleeding day (B).

Figure 4. Latency of flash visual evoked potential on post-menstruation day (A) and maximum bleeding day (B).
Conflicts of Interest
None.

REFERENCES
1. Kline LB, Grimson BS. Optic Neuritis. In: Kline LB (ed). Optic Nerve Disorders, Ophthalmology monographs. San Francisco: American Academy of Ophthalmology; 1996: 55-71.
2. MacKay DM, Jeffrey DA. Visually evoked potentials and visual perception in man. In: Jung R (ed). Handbook of Sensory Physiology. Vol VII/3. New York: Springer; 1973: 647-678.
3. Walsh TJ. Neuro-Ophthalmology clinical signs and symptoms. 2nd ed. Philadelphia: Lea & Febiger; 1985: 303-340.
4. Mushin J, Hogg CR, Dubowitz LM, Skouteli H, Arden GB. Visual evoked responses to light emitting diode (LED) photostimulation in newborn infants. Electroencephalogr Clin Neurophysiol 1984;58:317-320.
5. Ciganek L. The EEG response (evoked potential) to light stimulus in man. Electroencephalogr Clin Neurophysiol 1961;13:165-172.
6. Kaneda Y, Ikuta T, Nakayama H, Kagawa K, Furuta N. Visual evoked potential and electroencephalogram of healthy females during the menstrual cycle. J Med Invest 1997;44:41-46.
7. Shushtarian SM, Yahyavi SH. Study of visual evoked potentials during normal monthly cycle in normal female subjects. Biomed Sci Instrum 1999;35:165-167.
8. Kawakami M, Sawyer CH. Effects of sex hormones and antifertility steroids in brain thresholds in the rabbit. Endocrinology 1967;80:857-871.
9. Kluck N, O’Connor S, Hesselbrock V, Tasman A, Maier D, Bauer L. Variation in evoked potential measures over the menstrual cycle: a pilot study. Prog Neuropsychopharmacol Biol Psychiatry 1992;16:901-911.
10. Vingerling JR, Dielemans I, Witteman JC, Hofman A, Grobbee DE, de Jong PT. Macular degeneration and early menopause: a case-control study. BMJ 1995;310:1570-1571.
11. Behl C, Widmann M, Trapp T, Holsboer F. 17-beta estradiol protects neurons from oxidative stress-induced cell death in vitro. Biochem Biophys Res Commun 1995;216:473-482.
12. Párducz A, Perez J, Garcia-Segura LM. Estradiol induces plasticity of gamma-aminobutyric acid synapses in the hypothalamus. Neuroscience 1993;53:395-401.
13. Case AM, Reid RL. Effects of the menstrual cycle on medical disorders. Arch Intern Med 1998;158:1405-1412.
14. Chung SC, Goldfarb AH, Jamurtas AZ, Hegde SS, Lee J. Effect of exercise during the follicular and luteal phases on indices of oxidative stress in healthy women. Med Sci Sports Exerc 1999;31:409-413.
15. Atta HR, Brown IA. Intra-ocular haemorrhage in menstruation. J R Coll Surg Edinb 1987;32:34-36.