Visual evoked potentials

The effects of glaucoma on the latency of the multifocal visual evoked potential

S L Graham

Delays in signal conduction are not great enough to be useful clinically

In this issue of the *BJO* (p 1132) the paper by Rodarte *et al* reports on the effect of glaucoma on the multifocal multichannel visual evoked potential (mfVEP), specifically its effect on signal latency.1 Many previous publications have established that there is a loss of mfVEP amplitude in glaucoma.2 3 This paper confirms that there are some measurable effects on latency, but the delays in signal conduction are not great enough to be useful clinically with only 40% showing significant change. As a relative negative finding this is important if the mfVEP is to be used in the diagnostic setting.

It is consistent with our understanding of the mechanisms of cell death in glaucoma, where demyelination is not a feature, in contrast to optic neuritis where marked latency delays are the hallmark. In fact in our recent study,5 large mfVEP latency delays in the recovery phase of a first episode of optic neuritis may even be predictive of the later onset of multiple sclerosis. A recent paper by Danesh-Meyer *et al* has also reported mfVEP amplitude reductions in compressive optic neuropathy,6 with some latency delays but not as marked as in optic neuritis (personal communication). The relative losses of amplitude versus delay may help separate not only disease types, but possibly prognosis in these conditions. It had been hoped that latency delays in glaucoma may be useful as an early marker in glaucoma, since there are many previous studies on the conventional VEP (cVEP) where some delays were identified. Also, latency has greater reproducibility and less inter-subject variability so would therefore be a useful parameter to measure. Unfortunately, this study confirms that the delays are not substantial enough to use in diagnosis. We had previously found similar results with the Veris (Electro-Diagnostic Imaging, San Mateo, CA, USA) multifocal system using quadratic latency averages,4 and also with the AccuMap system (ObjectiVision, Sydney, Australia) with individual latencies.9 Many papers have examined the cVEP in glaucoma and identified latency changes.10 11 In an early study with an age corrected cohort of patients with open angle glaucoma (OAG) and ocular hypertension (OHT), the full field pattern VEP showed about 50% and 25% of patients, respectively, to have a delay in latency compared to normals.12 The predominant effect in other studies was a delay in p100 latency of around 20 ms12 13 and a phase shift in the steady state pattern visually evoked potential (PVEP).13 14 Horn *et al* reported that the peak time of a blue-yellow VEP had high sensitivity, and could be used to monitor progression.15 The consensus appears to be that for the cVEP there is definitely some delay detected, but the ability of the tests to reliably separate glaucoma from normals varies greatly between studies.

The amplitude of the mfVEP shows substantial reductions in glaucoma but latency delays are only mild

Rodarte *et al* in the current study raise the point that their results seem to be in contrast to a recent paper on cVEPs where extremely high sensitivity and specificity (100%) for the latency of the VEP in glaucoma was reported. It is interesting to note in that paper that even the OHT subjects (IOP >21 mm Hg but normal discs) were also all delayed and clearly demarcated from the controls. This implies very early pressure related dysfunction in a group that may not all be destined for clinical glaucoma, yet the mfVEP only identified minor delays in established glaucoma.

There is no clear explanation for the difference in the findings of these two reports, but clearly it is important to conduct a study to compare the two types of VEP (conventional and multifocal) in the same individuals with early glaucoma. This should help confirm known differences between the two tests and establish if there is a difference in the effects of glaucoma on latency.

Fortune and Hood16 have already done a comparative study in normals and shown that transient pattern reversal cVEP responses to relatively large field stimuli cannot be related simply to the sum of local mfVEP responses recorded with fast m-sequence stimulation. The amplitude of the full field response grew dramatically as the sequence was slowed, which was the result of several factors, including loss of hemifield polarity inversion, increased dominance of the lower hemifield, and overall growth in amplitude with slower reversal rates.

The cVEP is dominated by the central macular responses, and the lower central field more than upper, depending on electrode position. It is recorded with a uniform stimulus check size and a slow reversal rate throughout the field. It is a summed response from multiple striate cells of different orientation, and there can be different cancellation effects depending on the individual's underlying cortical convolutions. This may be why many previous full field studies have failed to show consistent amplitude loss in glaucoma, as location of the field loss (peripheral versus central, or superior versus inferior) may produce different effects on the net recorded response.2 It could also theoretically change the latency, as the shape and timing of the waveforms differ in different parts of the field, unlike the electroretinogram (ERG) which has the same shaped waveform throughout.

There are several differences between the two test techniques, which could contribute to differing results. The mfVEP dartboard stimulus is cortically scaled, with larger checks in the peripheral and smaller checks in the centre, to

---

For at least some of the reported discrepancies, further studies are certainly warranted.

Conventional forms of perimeter are dependent on subject responses and require a high level of cognitive ability to perform the test. This makes these tests challenging for individuals, particularly the elderly and children, and has driven the push towards forms of objective perimetry. The mfVEP shows promise as a means of achieving such a clinically useful test, using local amplitude reductions. It is necessary to use multiple channels, with a minimum of a vertically and horizontally oriented pair of bipolar electrodes so that all underlying dipole orientations are detected. In glaucoma with established field loss it has been found to be 95% sensitive and 90% specific, and can provide complementary functional data to current subjective methods. When investigating glaucoma subjects who have poor perimeter technique it can be extremely helpful. In investigating other optic nerve pathology, substantial delays are seen in optic neuritis, while in unexplained visual loss combining the mfVEP with the mFERG can help localise the level of the disease to retina or optic nerve/cortex.

The main limitation of the mfVEP as a form of objective perimeter remains intra-individual reproducibility and noisy recordings which can lead to false positives. There is still a level of patient cooperation required, together with technician experience to recognise noise such as alpha rhythm (patient losing concentration), muscle noise, and other artefacts. Further developments in mfVEP technology should be directed towards improving signal to noise ratios and thereby both increasing sensitivity and reducing variability.


Correspondence to: Stuart L Graham, Save Sight Institute, Sydney University, L4/187 Macquarie Street, Sydney 2000, Australia; stuart@eye.usyd.edu.au

Proprietary interest: The author is a consultant for Objectivision Pty Ltd.

REFERENCES


The effects of glaucoma on the latency of the multifocal visual evoked potential

S L Graham

doi: 10.1136/bjo.2006.097592

Updated information and services can be found at:
http://bjo.bmj.com/content/90/9/1077

These include:

References
This article cites 20 articles, 4 of which you can access for free at:
http://bjo.bmj.com/content/90/9/1077#BIBL

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections
Articles on similar topics can be found in the following collections

- Angle (1005)
- Glaucoma (987)
- Intraocular pressure (1001)
- Neurology (1346)
- Optic nerve (710)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/