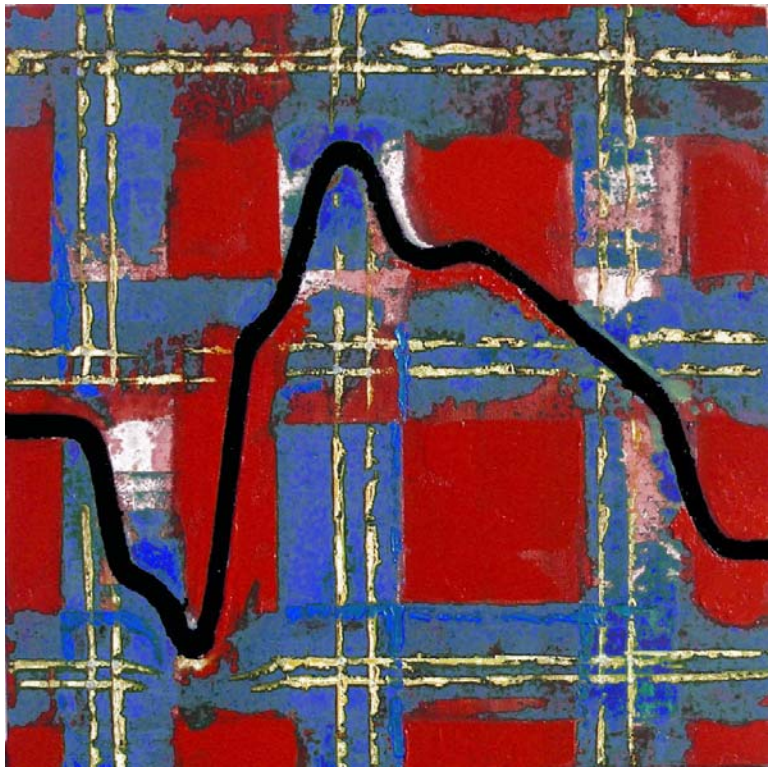
British Society
for
Clinical
Electrophysiology
of Vision
III Annual Symposium

Programme and Abstracts



BriSCEV III

Glasgow, Scotland
22-23 August
2005

BriSCEV III
Glasgow 22nd – 23rd August 2005

Welcome

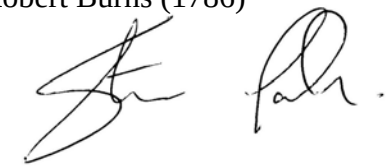
Dear Friends,

Welcome to the III BriSCEV symposium in Glasgow. The society was established in Nottingham in 2003 to improve communication between those groups specialising in electrophysiology of vision within the UK. Through regulation of training and the standardisation of reporting and testing the organisation hopes to improve the quality of electrophysiology in the UK.

There are a number of groups working in both clinical and experimental electrophysiology in Glasgow and their output in terms of research and clinical application has increased significantly in the past ten years. It is with great pleasure and pride that we welcome both the national and international electrophysiology societies to Glasgow.

Glasgow is a wonderful city full of warmth and charm. Its rapid expansion as one of Britain's largest and wealthiest cities in the late 18th Century can be attributed to its 'colonial' traders and its pivotal role in the industrialisation of the empire. This wealth brought an explosion of art and science and contributed to its reputation as the second city of the Empire. But it is the people of Glasgow that give it its humour and its reputation as a welcoming warm city with a cosmopolitan feel. We are sure you will enjoy both the scientific and social programme of the meeting and hope also you find the time to sample the city and leave with a generous portion of Scottish hospitality. BriSCEV as with ISCEV is an organisation with a common goal and a family feel. With that in mind I leave you with the words of one of Scotland's most famous sons.

"That man to man, the world, o'er
Shall brithers be for a' that."
Robert Burns (1786)



Stuart Parks
Chairman BriSCEV III Organising Committee

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Monday 22nd August

11:00 - 13:30	REGISTRATION & LUNCH
12:00 - 12:45	CLINICAL CASES SESSION Chairwoman: Chea Lim, Queens Medical Centre, Nottingham
12:45 – 13:30	*Lunch*
13:30 - 13:40	WELCOME & INTRODUCTION Stuart Parks, Gartnavel General Hospital, Glasgow
13:40 – 14:30	GUEST LECTURE GENETICS OF RETINAL DISORDERS Alan Wright, MRC Human Genetics Unit, Edinburgh
14:30 – 15:00	*Tea Break*
15:00 – 16:20	'NITTY GRITTY' SESSION Chairman: Stuart Parks, Gartnavel General Hospital, Glasgow
16:20 – 17:20	BRISCEV BUSINESS MEETING
18:30 – 23:00	EVENING FUNCTION Dinner and Ceilidh at the Piping Centre

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Tuesday 23rd August

09:00 – 10:30	ORAL PRESENTATIONS I Chairman: Colin Barber, Queens Medical Centre, Nottingham
10:30 – 11:00	*Tea Break*
11:00 – 12:30	POSTER PARADE Chairman: David Keating, University of Glasgow, Glasgow
12:30 – 13:30	*Lunch*
13:30 – 15:00	ORAL PRESENTATIONS II Chairwoman: Dorothy Thompson, Great Ormond Street Hospital, London
15:00 – 15:30	*Tea & Commercial Exhibition*
15:30 – 16:30	HOST LECTURE UNDERSTANDING THE MFERG David Keating, University of Glasgow, Glasgow

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GUEST LECTURE
GENETICS OF RETINAL DISORDERS

Alan Wright
MRC Human Genetics Unit, Western General Hospital, Edinburgh

Inherited retinal disorders (IRD) are common causes of impaired vision, affecting 1 in 2,000 of the general population. In addition, age-related macular degeneration (AMD) affects approximately 8% of those over age 65 years and increases exponentially with age. The economic impact of AMD is estimated to be between 50 and 100 million euros per year in UK (Bonastre J et al. (2002) Eur J Health Econ 3, 94-102) and the prevalence is expected to double by 2025. The first IRD gene was mapped in 1984, since when a further 160 genes have been mapped, of which 112 have been identified (http://www.sph.uth.tmc.edu/Retnet/). This includes 43 genes in which mutations cause retinitis pigmentosa (RP), the most genetically heterogeneous disorder in man. Animal models for many of these IRDs have been identified or constructed and advances in the treatment of models for congenital retinal dystrophies, such as Leber's congenital amaurosis, have provided grounds for cautious optimism that some will be treatable by gene replacement therapy. In AMD, a genetic variant influencing disease susceptibility has recently been identified in the complement factor H (CFH) gene, which provides significant insight into disease pathogenesis. On the one hand, genetics has divided single clinical entities such as RP into different subtypes, but it can also unify clinically different entities resulting from distinct mutations within single genes. Classification requires both genetic and clinical definitions. The need for precise diagnostic tools is greater than ever, and much remains to be learnt in the field of genotype-phenotype correlations.

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15:00 – 16:20 **'NITTY GRITTY' SESSION**
Chairman: Stuart Parks, Gartnavel General Hospital, Glasgow

15:00 – 15:20 POST CAPTURE PROCESSING OF ELECTRO-DIAGNOSTIC SIGNALS
Malcolm Brown *(Liverpool, UK)*

15:20 – 15:40 REPORTING
Graham Holder *(London, UK)*

15:40 – 16:00 MEASURES OF COMPARISON: DE-CONDITION YOUR REFLEX TO GO FOR CORRELATION
Michael Bach *(Freiburg, Germany)*

16:00 – 16:20 THE ELECTRORETINOGRAM OF MONKEYS, MICE AND MEN
John Robson *(Houston, USA)*

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POST CAPTURE PROCESSING OF ELECTRO-DIAGNOSTIC SIGNALS

Brown, M., Hagan, R., Fisher, A.
Clinical Engineering Dept. and Clinical Eye Research Centre, Royal Liverpool University Hospital, Liverpool

Purpose: To introduce the benefits of applying simple post-capture signal processing to electro-diagnostic signals, and to offer comment on the current ISCEV signal capture recommendations.

Summary: It is still the norm to capture an electrical response to a luminance or pattern stimulus via an amplifier with a fixed band-pass filter and then display the graph of the response over a few tens, or hundreds of milliseconds, and possibly average a number of such responses together. This may be coupled with a rudimentary artefact detection circuit to discard particular responses, usually based on a simple amplitude criterion.
The analogue filters used in biological amplifiers are far from perfect, and in particular, the nominal 'cut off' frequencies (e.g. 1 and 100Hz) represent points at which the signal amplification is already substantially reduced, and where the phase delay (timing) of the response is already seriously changed (45 degrees). They are also subject to 'out of band' interference, particularly at the bottom end, with 'slow' but relatively large signals from blink, eye movement, and electrode movement, causing major intrusions into the recorded signal.
Using a second stage of filtering and artefact rejection (or other Digital Signal Processing – DSP) can remove most of these problems. Further, the application of post-capture DSP suggests changes to the setting of the biological amplifier.
In particular, the capture bandwidth can be larger, so that the signal is not distorted at the nominal 'cut-offs' and the upper frequency 'cut-off' needs to be well below the Nyquist frequency (digital sampling rate/2) to allow for possible out-of-band components (e.g. emg interference) being accepted (albeit at reduced amplification) by the sampling circuits. Also it becomes desirable not to apply artefact rejection at the biological amplifier stage, except to avoid amplifier block (lock-up).
A further consideration is that the typical short recording window (i.e. less that the inter-stimulus interval) discards useful information about the response and artefacts. A better idea is to record a single stream of data throughout the period of repeated stimulation and perform the signal processing (and averaging) on this complete data stream. ISCEV Standards and Guidelines for electro-diagnostic testing suggest amplifier bandwidths which in some cases may cause unnecessary variation in the responses, thereby reducing diagnostic accuracy.

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REPORTING

Graham Holder
Moorfields Eye Hospital, London

The presentation will address aspects of reporting electrophysiological data. The nature of the report, including technical considerations, the importance of placing the data in clinical context, of determining whether the clinical question at referral has adequately been answered, and of considering every report as a potential medico-legal case, will be discussed.

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MEASURES OF COMPARISON: DE-CONDITION YOUR REFLEX TO GO FOR CORRELATION

Michael Bach
Universitats-Augenklinik Freiburg, Germany

We are often faced with comparisons across methods – be it DTL vs. Burian-Allen, or test-retest variability. It is a common reflex to use the correlation coefficient for this. I will illustrate that several properties of the correlation coefficient are disadvantageous for this task:
1. It is normalized for variance, thus it confounds retest variability and total variance.
2. It is not affected by systematic errors.
3. It is asymmetric.
4. Its value is not intuitive. While r-squared can be interpreted as "% variance explained", this does not lead to appreciation of test-retest reproducibility in an obvious way.

A number of alternative measures do exist to assess such comparison. The Bland-Altman plot[1] is a useful graph which can highlight typical error sources, but does not offer a quantitative measure. The so-called "coefficient of reproducibility[1]" has a dimension and is thus somewhat limited. I will argue for the less widely used "coefficient of variation" (CV), which is calculated as CVi=SDi/mi with SDi=standard deviation, and mi=mean, both for any given pair i of measurements. The mean CV across all i subjects, expressed in %, provides an intuitive and adequate measure of reproducibility.

[1]Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986; 1: 307–310.

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THE ELECTRORETINOGRAM OF MONKEYS, MICE AND MEN

John Robson
University of Houston College of Optometry, USA

The existence of an electrical response of the eye to light was independently discovered by Holmgren (1865-66) in Uppsala and by Dewar and McKendrick (1873) in Edinburgh. Though these investigators at first mostly recorded from the eyes of frogs because the eyes of this cold blooded animal continued to function normally for quite a long time after removal from the body, they found that similar responses could be recorded not only from the eyes of other amphibians, fish, reptiles and crustaceans but also, albeit briefly, from the isolated eyes of warm-blooded mammals and birds. Experiments were greatly eased when it was realized that the electrical response of the vertebrate eye was generated by the retina itself rather than by the optic nerve, as had originally been supposed, and that this electrical response could be satisfactorily recorded from in situ eyes of anaesthetized or paralyzed mammals (cat, dog, rabbit, guinea pig) and birds (pigeon, owl). With the primitive equipment then available it was just possible to record an electrical response from the eye of an unanaesthetised human but this could not be done sufficiently well to study the human electroretinogram (ERG) in any detail – certainly not well enough to make it a possible clinical tool!

Numerous technical advances have now made it possible to record the ERG with ease, so that it is feasible to use the ERG not only to investigate normal retinal function but also to understand the aetiology of various retinal disorders and to aid in their clinical diagnosis. But to make good use of the ERG in these contexts it is necessary to be able to interpret the electrical recordings in terms of the contributions to the normal ERG that are made by the various different cell types of the retina. Identification of the retinal sources of electrical current that contribute to the ERG has relied largely on pharmacological and other experimental studies that have been undertaken in various non-human animal species. However, in recent years such studies have focused on macaques, whose eyes are very similar to those of humans, and mice whose retinas can be genetically manipulated to induce various kinds of malfunction. Because of the small size of the mouse eye, the electroretinogram of genetically modified animals may be able to provide information about some aspects of normal retinal function that cannot be obtained in other ways.

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09:00 – 10:30 **ORAL PRESENTATIONS I**
Chairman: Colin Barber, Queens Medical Centre, Nottingham

09:00 – 09:15 POST-HOC FILTERING OF OSCILLATORY POTENTIALS FROM ERGs
Michael Bradnam *(Glasgow, UK)*

09:15 – 09:30 AN ADAPTIVE HEURISTIC ARTEFACT REJECTION SCHEME FOR VISUAL ELECTRODIAGNOSTIC RECORDINGS
Anthony Fisher *(Liverpool, UK)*

09:30 – 09:45 POLYUNSATURTED FATTY ACIDS (PUFAs) AND EARLY MATURATION OF THE ERG AND VEP IN INFANTS BORN AT TERM
Daphne McCulloch *(Glasgow, UK)*

09:45 – 10:00 VARIATIONS IN THE NORMAL MULTIFOCAL VEP
Yaqin Wen *(Nottingham, UK)*

10:00 – 10:15 CRT VS LCD STIMULUS DISPLAY DURING MFVECP RECORDINGS
Jennifer Chisholm *(Glasgow, UK)*

10:15 – 10:30 COMPARISON OF CHROMATIC VEPS AND MINIMUM MOTION AND MINIMUM FLICKER ASSESSMENTS OF NORMAL AND SIMULATED LUTEAL PIGMENT
Anthony Robson *(London, UK)*

POST-HOC FILTERING OF OSCILLATORY POTENTIALS FROM ERGs

Bradnam, M.S.[1,2], Hamilton, R.[1,2].

[1]*Department of Clinical Physics, Greater Glasgow NHS Board Yorkhill Division*

[2]*Department of Clinical Physics, University of Glasgow*

Purpose: Post-hoc filtering of ERGs to obtain OPs can introduce errors by not filtering from the first time point. Creating pseudo pre-stimulus data using ensures filtering from the first data point.

Methods: Sampling frequency of the analogue ERG signal was 2000Hz, and the sample window was 250ms with no pre-stimulus interval. An off-line, 57 point, high-pass Butterworth filter was designed and created in Turbo Pascal with a 75Hz 3dB cut-off. Filter coefficients were calculated then incorporated into routine clinical analysis software for ongoing use. Test files of pure sinusoids at 100Hz, 75Hz, 50Hz and 25Hz were created and used to validate filter performance. In order to subject all ERG data points to the same filter conditions, pre-conditioning to create a pseudo-pre-stimulus interval was required. The 57 point Butterworth filter, when filtering the first ERG data point, had no data at points 0 to -27. Therefore, the first 28 real ERG data points were inverted in time and amplitude to create a pseudo-pre-stimulus interval without discontinuities and to avoid filtering distortions.

Results: The validated 75Hz cut-off high-pass digital filter and the pre-conditioning was successfully incorporated into routine clinical analysis software and used to filter OPs from adult (N=2) and preterm infant (N=138, age range 30-66 weeks postmenstrual age) ERGs. OPs were consequently clearly visualised in adult and in more mature infant ERGs.

Conclusions: Post-hoc filtering of ERGs to isolate OPs is possible without introducing distortions if care is taken to pre-condition the ERG data such that all ERG data points from t=0 are subject to the same filtering conditions.

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AN ADAPTIVE HEURISTIC ARTEFACT REJECTION SCHEME FOR VISUAL ELECTRODIAGNOSTIC RECORDINGS

Fisher, A., Hagan, R., Brown, M.
Department of Clinical Engineering, Royal Liverpool University Hospital

Background: Coherent averaging is the corner-stone of visual electrodiagnostic recording. The assumption is that the averaging process recovers the signal from uncorrelated noise with an SNR improvement proportional to the square root of the number of signal epochs averaged. This process is described by the Central Limit Theorem which states that the PDF (probability density function) of the averaged population is independent of the PDFs of the contributing samples. This assumption is usually justifiable in the clinical situation for uncorrelated noise sources of the same order of magnitude and morphology as the signal to be recovered (e.g. the background on-going EEG with respect to the VEP), however, it is likely to fail significantly for noise sources arising from eye movements (ocular movements and blinks). These signal artefacts, over the time interval relevant to normal recordings, cannot be treated as random but rather as spontaneous and heteromorphic: hence it is very unlikely that they will have zero mean. Inevitably such artefacts corrupt the estimate of the signal recovery. This paper presents a post hoc analysis to identify and remove individual noise-corrupted epochs using a number of intuitive heuristic rules which adapt continuously to the PDFs of the artefactual noise sources using an identification process based on only their first order statistics.
Methods: Conventional ERG and PERG recordings were made. Data were stored as arrays of discrete epoch segments to allow stimulus-by-stimulus analysis. The parametric distributions of these heuristic models (including DC-shift, DC-ramp and 'trend') are extracted for each epoch and a weighting applied based on their PDF prior to inclusion in the ensemble average: 60% of the samples, selected on the basis of the 10th to 60th percentile range are attributed the weight of 1, with the remainder weighted adaptively between 1 and zero.
Results: Improvement in SNR ranged from approximately 10 to 60% depending on the level of eye movement artefact. This improvement was characterised formally as the reduction in the time required to converge the average (recovered) signal to within 0.63 (i.e. 1-1/exp) of its final (asymptotic) value.
Conclusions: The use of an adaptive heuristic model to minimise the inclusion of eye movement noise artefacts in the signals recovered by coherent averaging improves the SNR and decreases the recording time to a degree potentially useful in clinical recordings. This method deals with artefacts of magnitudes below those detected by conventional 'hard limit' rejection schemes. It is applicable post hoc to discrete data epochs without reliance on the original continuous data record.

POLYUNSATURTED FATTY ACIDS (PUFAs) AND EARLY MATURATION OF THE ERG AND VEP IN INFANTS BORN AT TERM

McCulloch, D.[1], Malcolm, C.[1], Hamilton, R.[2], Montgomery, C.[3], Weaver, L.[3]

[1]Department of Vision Sciences, Glasgow Caledonian University; [2]Department of Clinical Physics, Yorkhill NHS Trust, Glasgow; [3] University of Glasgow, Department of Child Health, Royal Hospital for Sick Children

Purpose: Long chain polyunsaturated fatty acids, particularly docosahexaenoic acid (DHA), are essential for retinal and neurodevelopment in the foetus and infant. VEPs and ERGs were used to investigate whether maternal supplementation enhances the maturation of the retina and/or visual pathways in healthy infants born at term.

Methods: In a double-blind prospective supplementation trial, 100 pregnant women were randomly assigned to receive either a fish oil supplement or oleic acid placebo capsules from 15 weeks gestation until delivery. Total fatty acids (%TFA) and concentrations in maternal red blood cells (RBC) and plasma were analysed at 15, 28 and 40 weeks gestation and in infants at delivery from umbilical cord blood. Full-field ERGs, including a scotopic blue intensity-series (n=41) and a bright white flash, were recorded shortly after birth (1.8±1.3 days). Naka-Rushton functions were fit to the intensity-series. Infant VEPs were recorded to pattern reversal stimuli at 50 and 66 weeks post conceptional age.

Results: DHA status was higher in the supplemented mothers at 28 weeks and at delivery (rpt. meas. ANOVA, $p<0.05$) but maternal supplementation did not significantly alter the DHA status in infant cord blood. Thus, there were no differences between infants in the maternal supplemented and placebo groups in any measure of visual maturation. However, maturity of the retina at birth was positively associated with the DHA status of the infant. DHA in infant cord blood was correlated with log (retinal sensitivity) from the Naka-Rushton function ($p < 0.01$). The median retinal sensitivity of infants in the highest quartile for DHA in cord blood was 2.5 times higher (+0.4 log units) compared with that of infants in the lowest quartile. DHA status in cord blood at birth was also associated with enhanced visual pathway maturation (earlier P100) on follow up ($p<0.01$)

Conclusions: An association between the DHA status of neonates and both retinal sensitivity and visual pathway maturation was demonstrated. However, maternal DHA status over a wide range is not significantly associated with infant visual function and no direct benefit of maternal supplementation was demonstrated.

Supported by a grant from the Chief Scientists' Office, Scottish Office, Dept. of Health. K/MRS/50/C2730.

Tuesday 23rd August

VARIATIONS IN THE NORMAL MULTIFOCAL VEP

Wen, Y., Barber, C.
Medical Physics Department, Queen's Medical Centre Nottingham

Purpose: To investigate the variations of the mfVEP in normal subjects and to make an appropriate interpretation for clinical investigations.

Methods: Multifocal VEPs were recorded and analysed using VERIS 4.7. Six subjects aged between 27 and 61 years with no known abnormalities of visual system participated in the study. Dartboard pattern stimulus with 48 elements, covering 60° of the visual field, was presented on a monitor refreshed at 75 Hz. Contrast reversals were determined by a pseudorandom m-sequence with a total of 2^{14}-1 steps, containing 2 frames in each m-step. The recording time was about 7 minutes for each run and two runs were recorded for each subject. The signal was amplified by 100,000 times and band-pass filtered between 3 and 100 Hz. The second order kernel average responses from the two runs were analysed.

Results: The amplitude and waveform vary across individuals, as well as across the field within an individual. The variations across the field within an individual are apparent not only between the upper and lower, the left and right hemi-fields, but also within the same quadrant.

Conclusions: Our results confirmed that there is a need for multi-channel recordings for the mfVEP to avoid mimicking a field defect from a localised area with very low amplitude when viewed from a single channel. Also, great caution is needed when analysing data by grouping responses together even from the same quadrant to avoid phase reversal cancellations.

CRT VS LCD STIMULUS DISPLAY DURING MFVECP RECORDINGS

Chisholm, J., Keating, D., Parks, S.
Tennent Institute of Ophthalmology, Gartnavel General Hospital, Glasgow

Purpose: To determine the impact of the use of a cathode ray tube monitor or an LCD screen to display multifocal visual evoked cortical potential stimuli on signal detection.

Methods: 4 normal healthy volunteers submitted to mfVECP testing. Subjects performed 16-bit mfVECPs with dartboard stimulus displayed on a CRT and an LCD screen. Recordings were made with an in-house, 4-channel, multifocal visual electrophysiology system. Brightness levels were adjusted to achieve luminance and contrast matching between the two display systems. Luminance was measured with the Minolta luminance meter.

Results: Recordings made during stimulation with the CRT monitor resulted in detecting a signal in 555 out of 960 (58%) potentially detectable waveforms (4 subjects * 4 channels * 60 waveforms). 449 out of 960 waveforms were detected when stimulation was provided by the LCD method. A paired two-tailed student's t-test returned a probability of $p=0.0026$. The null hypothesis that the detectability rates come from the same population for stimulation by CRT & LCD techniques can therefore be rejected at the $p<0.005$ level.

Conclusions: 100% signal detection was not achieved in any of the recordings. Some of the signals evoked were too small and/or in the wrong orientation to be detected by some channels. The detection rate appears improved with the CRT monitor.

COMPARISON OF CHROMATIC VEPS WITH MINIMUM MOTION AND MINIMUM FLICKER ASSESSMENTS OF NORMAL AND SIMULATED LUTEAL PIGMENT

Robson A.[1], Holder G.[1], Moreland J.[2], Kulikowski J.[3]

[1]Moorfields Eye Hospital, London. [2]Keele University, Staffordshire. [3] UMIST, Manchester.

Purpose: To assess subject-specific macular luteal pigment (MP) using chromatic visual evoked potentials.

Methods: Isoluminant Red/Green (R/G), Blue/Green (B/G) and Tritan gratings (2 cycles/deg, diameters 3-12 degrees) were used to elicit onset-offset VEPs from 14 normal subjects using a colour monitor (broadband phosphor emissions). Isoluminance was determined using minimum flicker. Chromatic selectivity was assessed by comparing onset components with achromatic and chromatic reversal VEPs and by Fourier analysis, whereby colour-specific responses are dominated by the fundamental and achromatic VEPs by the 2nd harmonic. The degree of chromatic VEP response selectivity was also expressed as an index; onset negativity/(onset negativity + onset positivity). MP optical density (OD) profiles were measured between 0 and 7.4 degrees eccentricity for the same subjects using motion photometry (narrow-band stimuli) and flicker photometry (broadband phosphor emissions). Minimum flicker values were also obtained through different concentrations of carotenoid pigment, extracted from vegetables.

Results: Onset VEPs elicited by 3-degree gratings at isoluminance were characterized by a negative wave; reversal and achromatic VEPs by positive components. In subjects with high peak MPOD, increasing the diameter of B/G gratings beyond 3-degrees resulted in VEPs with additional positive onset components which lowered the index of selectivity and the power of the fundamental. For onset VEPs to 9-degree B/G gratings, the peak MPOD showed negative correlation with the power of the VEP fundamental (r=0.70). For onset VEPs to 9-degree Tritan gratings, the peak MPOD showed negative correlation with the index of chromatic VEP selectivity for low/moderate contrast gratings (r = 0.83) and for high contrast gratings (r =0.92). MPOD values obtained by flicker photometry, using the same colour monitor used to generate VEPs, correlated with those obtained using minimum motion. Minimum flicker assessment of different concentrations of carotenoid pigment correlated closely with measured absorbance values.

Conclusions: The loss of chromatic selectivity seen in onset VEPs generated by large gratings modulated along B/G or Tritan axes can be related to subject-specific levels of MP. Broadband chromatic stimuli may be used in the assessment of macular pigment.

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11:00 – 12:30 **POSTER PARADE**
Chairman: David Keating, University of Glasgow

1001 ELECTROPHYSIOLOGICAL INVESTIGATION OF THE EFFECTS OF SYSTEMIC OXYGEN INHALATION ON THE OSCILLATORY POTENTIALS AND SCOTOPIC B-WAVE IN DIABETES MELLITUS
Jennifer Cumiskey (*Cardiff, UK*)

1002 IS THERE A ROLE FOR mfERG AS A PROGNOSTIC TOOL IN BIRDSHOT CHORIORETINOPATHY?
Mohammed Abu-Bakra (*Glasgow, UK*)

1003 VISUAL EVOKED POTENTIALS ELICITED BY SINUSOIDAL FLICKER IN AMBLYOPIC SUBJECTS
David Nicol (*Glasgow, UK*)

1004 AN AUTOMOMOUS PATTERN GENERATOR FOR VISUAL ELECTRODIAGNOSTIC TESTING
Stephen Riley (*Liverpool, UK*)

1005 COMPARING THE MFERG RESPONSE TO 'SLOW' AND 'FAST' STIMULATION USING A ROLAND RETISCAN
Richard Hagan (*Liverpool, UK*)

1006 CLINICAL AND ELECTROPHYSIOLOGICAL STUDY OF CENTRAL RETINITIS PIGMENTOSA (RP)
Subhadra Jalali (*Hyderabad, India*)

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Poster Presentations Continued

1007 MUTATIONS IN THE ABCA4 GENES AND THEIR ASSOCIATED CLINICAL AND ELECTROPHYSIOLOGICAL FEATURES IN FAMILIES WITH AUTOSOMAL RECESSIVE RETINAL DYSTROPHIES
Subhadra Jalali (*Hyderabad, India*)

1008 REPEATABILITY OF THE MULTIFOCAL ERG
Angela McCall (*Glasgow, UK*)

1009 IS THE MFERG A VALID TEST OF MACULAR FUNCTION IN PATIENTS WITH CATARACT?
Sinead Dudgeon (*Glasgow, UK*)

1010 MULTIFOCAL ERG IN VIGABATRIN INDUCED NEURORETINAL TOXICITY: A FIVE YEAR FOLLOW UP
Pedro Gonzalez (*Glasgow, UK*)

1011 ASSESSMENT OF CONTRAST SENSITIVITY IN INFANTS AND CHILDREN: A NOVEL TEST USING STEADY-STATE VISUAL EVOKED POTENTIALS (SSVEPS)
Julie Calvert (*Glasgow, UK*)

1012 MULTIFOCAL ERG: LESSON 1
Malcolm Brown (*Liverpool, UK*)

Tuesday 23rd August

ELECTROPHYSIOLOGICAL INVESTIGATION OF THE EFFECTS OF SYSTEMIC OXYGEN INHALATION ON THE OSCILLATORY POTENTIALS AND SCOTOPIC B-WAVE IN DIABETES MELLITUS

Cumiskey, J., Drasdo, N., Owens, D., North, R.
School of Optometry and Vision Sciences, Cardiff University

Purpose: The oscillatory potentials (OPs) are known to reflect inner retinal function and have been found to be reduced in subjects with diabetes mellitus (DM). The scotopic b-wave is thought to reflect primarily the activity of the rod bipolars and has also been found to be reduced in DM. Since retinal hypoxia has been implicated in abnormalities of visual function we investigated the effect of 5 minutes of systemic oxygen inhalation on the OPs and scotopic b-wave in subjects with DM.

Methods: OPs: Fifteen subjects with Type II DM and an age-matched group of controls were recruited. The mean age of the diabetic group was 62 yrs (SD 6.0) with a mean disease duration of 8 yrs (SD 5.3), who exhibited no visible signs of diabetic retinopathy (NDR). The mean age of the control group was 62 yrs (SD 10.6). OPs were recorded monocularly after 20 mins dark adaptation to 6 white flashes, intensity 3 $cdsm^{-2}$ (ISCEV standard), 3 ms duration at 15 s intervals (first two flashes treated as conditioning flashes). Subjects inhaled 100% oxygen for a period of 5 mins through a 60% Ventimask. This procedure was then repeated: a) after 2 mins of oxygen inhalation and then b) 2 mins, c) 7 mins and d) 12 mins after removal of the mask. B-wave: The scotopic b-wave was recorded monocularly in 17 subjects with NDR, mean age 62 yrs (SD 6.3), and mean disease duration 7 yrs (SD 5.1) and in a group of 18 age-matched controls mean age 62 yrs (SD 10.4). It was recorded after 20 mins dark adaptation to a 5 ms green flash (peak 515 nm), intensity 0.0012 $cdsm^{-2}$ (ISCEV standard), at 0.5Hz. It was then recorded both during and after 5 mins of oxygen inhalation as described above.

Results: OPs: Oxygen inhalation increased the summed OP amplitude with a significant increase of 12% and 19% from baseline at 7 and 12 mins after removal of the mask respectively using Bonferroni pairwise comparisons ($p<0.001$ RM ANOVA). No significant change in summed amplitude was found in the controls ($p=0.154$). B-wave: An increase in amplitude was also observed for the scotopic b-wave, of 10% and 8% in the NDR group at these respective time points, though this did not reach significance using the RM ANOVA.

Conclusions: Oxygen inhalation significantly increased the summed amplitude of the OPs in NDR subjects while control subject amplitudes remained stable. The scotopic b-wave amplitude increased for both groups though not significantly in this experiment. The increase in summed OP amplitude with oxygen inhalation supports the suggestion of impaired retinal autoregulation in subjects with DM even when no retinopathy is apparent, and suggests that tissue hypoxia may be present in the surface layers of the retina in these subjects.

Tuesday 23rd August

IS THERE A ROLE FOR MFERG AS A PROGNOSTIC TOOL IN BIRDSHOT CHORIORETINOPATHY?

Bakra, M., Gavin, M., Keating D., Parks S.
Tennent Institute of Ophthalmology, Gartnavel General Hospital, Glasgow

Purpose: To investigate the correlation between multifocal electroretinogram (mfERG) findings in patients with birdshot chorioretinopathy (BSCR) and its clinical course.

Methods: Ten consecutive patients (five females and five males) referred to the regional uveitis service in the west of Scotland were recruited in this largely retrospective observational study. Their medical notes were systematically reviewed. All recruited patients prospectively had serial mfERGs between 2002 and 2004. They have also been serially monitored with Snellen visual acuity and Goldmann visual fields.

Results: Average age was 55.8 years (median 57, range 33-75 years). Mean follow-up since diagnosis was 59.5 months (median 30, range 2-192 months). Nine of the ten patients were HLA-A29 positive. Treatment was with oral prednisolone (n=3), cyclosporine (n=1), mycophenolate mofetil(n=1), prednisolone and cyclosporine (n=2) or a combination of the three agents (n=3). Prescribing a certain regimen was dictated by patients' tolerance of treatment. In BSCR, mfERGs show variable reduction in response amplitude and timing. Three patients who maintained normal mfERG responses still have 6/6, N5 Snellen acuity. A fourth patient who stopped her treatment showed deterioration from normal mfERG responses followed by subjective deterioration and worsening of Snellen acuity. The remainder had subtle, significant or marked reduction in response amplitude and delay with similar degree of subjective deterioration and reduction in Snellen acuity as well as worsening of Goldmann visual fields.

Conclusions: Our results showed that mfERG findings could act as a useful predictive tool to titrate immunosuppressive treatment in these patients.

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VISUAL EVOKED POTENTIALS ELICITED BY SINUSOIDAL FLICKER IN AMBLYOPIC SUBJECTS

Nicol, D., McCulloch, D., Shahani, U., Manahilov, V.
Vision Sciences Department, Glasgow Caledonian University

Purpose: Amblyopia is characterised by deficits in spatial resolution and localisation while temporal resolution may remain largely unaffected. We recorded VEPs to monocular and binocular luminance modulation across a range of temporal frequencies for comparison in amblyopic and control subjects.

Methods: Eleven amblyopic subjects (interocular difference of VA greater than 0.1LogMAR, stereoacuity less than 60'') were compared with eleven control subjects (VA 0.00 LogMAR or better each eye, stereoacuity 60'' or better). VEPs were recorded to full field sinusoidally modulated flicker presented in an LED Ganzfeld stimulator at 10 stimulus frequencies between 3Hz and 60Hz. Electrode sites were Oz, O3, O4 and Pz. Right eye, left eye and binocular recordings were made in a random order. A light occlusive eyepatch was used for monocular testing. Off line Fourier transform was used to record the steady state VEP amplitudes at the fundamental (F1), double (F2) and triple (F3) harmonics of the stimulus frequency.

Results: For Oz, both binocular and monocular F1 amplitudes were optimal at 21.2Hz while F2 was optimal at 5.3Hz. At each harmonic, monocular VEPs from the amblyopic subjects did not differ significantly between eyes, or from the VEPs of the control eyes, across the range of stimulation frequencies. Additionally, amblyopic subjects showed no significant interocular differences for any stimulus condition or harmonic. Both controls and amblyopes show binocular summation of the temporally modulated VEP ($p=0.0001$)

Conclusions: There were no differences in temporally modulated monocular VEPs between control and amblyopic eyes or between amblyopic and fellow eyes. Both controls and amblyopes show binocular summation of the temporally modulated VEP.

AN AUTONOMOUS PATTERN GENERATOR FOR VISUAL ELECTRODIAGNOSTIC TESTING

Riley, S., Fisher, A., Hagan, R., Brown, M.
Department of Clinical Engineering, Royal Liverpool University Hospital, Liverpool

Background: Modern personal computers and operating systems can easily produce images of greater complexity than those used in visual electrodiagnostic testing. However, to change these images at precise known times requires an operating system and /or hardware that is specifically designed for that purpose. Whilst a number of systems are available commercially, here we present an effective economic solution exploiting the ready availability of high performance embedded micro-controllers.

Purpose: To implement an autonomous video pattern generator for visual electrodiagnostic testing.

Methods: PIC (Microchip Ltd.) 18F258 microcontrollers were used which have a shared program and data memory of 32 kb. The size of a single 640 by 480 black and white image, if stored as a bitmap without any compression, is 37.5 kb. For this reason, each line of the image was produced as a sequence of black or white segments of variable length. Video signals were generated to both composite video and RGB standards. The design comprised: one master PIC, generating the horizontal and vertical synchronisation signals and 4 slave PICs, producing alternate image lines. The time intervals required to produce the hexagonal patterns were calculated in Matlab (Mathworks UK Ltd.) and the PICs were programmed using PIC C (CCS Inc.) and inline MPLAB assembly (Microchip Inc.)

Results: Alternating checker-board and hexagon patterns were produced, with each hexagon changing in an independent random sequence of 511 steps. These patterns include up to 37 hexagons in black and white for composite video and up to 19 hexagons in up to 8 colours in RGB. The horizontal resolution is limited by the smallest change in the variable time intervals used to produce each line. In PIC C the smallest change is 3 instruction cycles, which take 0.3 µs. In composite video the image portion of each line is drawn in 52 µs and so the horizontal resolution is less than 52 µs / 0.3 µs = 173. In RGB the image portion of each line is drawn in 31.8µs and so the horizontal resolution is less than 106.

Conclusions: It has been demonstrated that microcontrollers can produce images for electrodiagnostic testing, but not at the horizontal resolution of PC based systems. To improve the horizontal resolution requires faster microcontrollers and /or certain assembly programming techniques.
The design is ‘scaleable’, increasing the number of slave PICs allows images with greater vertical resolution or a greater number of hexagons. A single PIC is sufficient to produce checker board images. The design has some flexibility in the types of images it can produce.

This poster presentation will include a demonstration of the working system.

Tuesday 23rd August

COMPARING THE MFERG RESPONSE TO 'SLOW' AND 'FAST' STIMULATION USING A ROLAND RETISCAN

Hagan, R., Brown, M., Fisher, A.
Clinical Engineering Dept., and Clinical Eye Research Centre, Royal Liverpool University Hospital

Purpose: To demonstrate the differences in mfERG responses to 'slow' and 'fast' stimulation using the Roland Retiscan, and to consider the implications.

Methods: The Roland Retiscan has a default setting using a 'slow' stimulation rate. It uses five CRT frames per step of the stimulating sequence. The first frame in each step is white or black for each segment according to the sequence, and the other four frames are always black, giving a minimum inter-stimulus of interval of 83 ms. Most other mfERG systems use a 'fast' stimulation rate, in which each sequence step lasts only one frame, so that the minimum inter-stimulus is 16.6ms (for 60Hz scan rate). In this study a Roland Retiscan was driven at 60Hz, with 19 segments, 4:1 distortion, in a 40 degrees diameter field. Initial recording bandwidth (analogue) was 2-300Hz. On each test subject an mfERG was performed twice, once at the default 'slow' rate and again at the 'fast' rate, with no other parameter being changed.

Results: Responses of shorter latency and reduced amplitude were recorded to the 'faster' stimulation. There was also a marked morphological change.

Conclusion: It has been shown that by running the Retiscan at a fast stimulation rate a different signal is obtained. It is thought that this faster stimulation will produce more non-linear responses from the retina, which on the one hand may provide additional diagnostic information in the higher order Kernels, but may also cause more cross-contamination of segments with shorter stimulating sequences.

Tuesday 23rd August

CLINICAL AND ELECTROPHYSIOLOGICAL STUDY OF CENTRAL RETINITIS PIGMENTOSA (RP)

Jalali S., Ram, L.S.M., Sumasri, K.
Smt. Kanuri Santhamma Retina Vitreous Centre, L V Prasad Eye Institute, Hyderabad, India

Purpose: To evaluate the clinical and electrophysiological characteristics of central RP.

Methods: The clinical findings and electrophysiological parameters of consecutive cases of central RP were entered retrospectively into a datasheet from the ERG data bank, clinical records and fundus photographs. Central RP included patients with idiopathic, bilateral, symmetric, central pigmentary retinopathy without associated chorioretinal atrophy, peripheral retinal involvement or signs of inflammation. The datasheet was analysed for patient characteristics and ERG patterns. Patients with incomplete medical records were excluded from the study.

Results: 36 eyes of 18 consecutive patients (11males, 7 females) with central RP were studied. Mean age of onset of symptoms was 26 years (range 1-63; median 20 years). Family history of similar condition was seen in 5/18 patients. Snellen BCVA was <20/200 in 22 eyes and more than 20/50 in 8 eyes. All eyes had reproducible, subnormal ERGs and none had extinguished waveforms. ERG pattern was cone-rod type in 8 patients, rod-cone type in 6 patients and variable patterns in 4 patients. Colour vision with Ishihara charts was abnormal in 13/16 patients where it was checked. Low vision aids achieved independent reading vision in 10 patients.

Conclusions: Central RP did not show any gender preference and can be familial. Age of onset was variable. ERG was preserved, though subnormal as opposed to the extinguished ERG seen in typical RP. Both cone-rod and rod-cone types of ERG patterns were seen. In spite of centrally located lesions, low vision aids helped to improve reading vision.

MUTATIONS IN THE ABCA4 GENES AND THEIR ASSOCIATED CLINICAL AND ELECTROPHYSIOLOGICAL FEATURES IN FAMILIES WITH AUTOSOMAL RECESSIVE RETINAL DYSTROPHIES

Jalali S., Ram, L.S.M., Sumasri, K.

Smt. Kanuri Santhamma Retina Vitreous Centre, L V Prasad Eye Institute, Hyderabad, India

Purpose: To report mutations in the ABCA4 (ATP-binding cassette subfamily A member 4) genes and the clinical and electrophysiological features of the disease in two Indian families with autosomal recessive retinal dystrophy.

Methods: Affected and unaffected family members of patients with primary retinal dystrophy underwent complete clinical ocular evaluation including Snellen visual acuity, slit-lamp biomicroscopy, applanation tonometry, fundus examination, electrophysiology, and visual field testing. Blood samples were collected for isolation of genomic DNA after obtaining informed consent. To screen for the disease locus among known genes causing RP and /or retinal dystrophy, we looked for homozygosity in affected individuals at polymorphic microsatellite marker loci that flank 21 different genes for retinal dystrophy. Two or more markers were screened for each locus. Exons of the ABCA4 genes were amplified using specific primers and sequenced bidirectionally.

Results: A total of 13 families of autuosomal recessive Retinal dystrophy were screened. Screening of 42 microsatellite markers revealed homozygosity for markers that flanked the ABCA4 locus in 2 families, RP109 and RP111, with 3 and 2 affected individuals respectively. We identified a homozygous nonsense mutation Arg 2030Stop in affected members of RP109, and a homozygous single base deletion leading to frameshift, c1225delA in all affected of RP111. Clinical features included a predominant macular involvement in addition to the diffuse peripheral retinal degeneration in all affected. The electroretinogram showed variability with 2 affected showing a cone-rod type of pattern and 3 affected had nearly extinguished (less than 50microvolt) ERG responses. Phenotypic and electrophysiological characteristics ranged from Retinitis Pigmentosa to a cone-rod macular dystrophy like presentation.

Conclusion: The mutations in ABCA4 gene reported here are associated with widespread forms of retinal dystrophy having additionally a predominant macular involvement. Phenotypic and electrophysiological heterogeneity seen in the affected individuals is reported.

Tuesday 23rd August

REPEATABILITY OF THE MULTIFOCAL ERG

McCall, A., Keating, D., Gonzalez, P., McQuiston, A., Parks, S.
ElectroDiagnostic Imaging Unit, Gartnavel General Hospital, Glasgow

Purpose: To investigate the repeatability of the multifocal ERG using two different stimulus delivery methods.

Methods: Multifocal ERGs were performed on five control subjects using two different multifocal stimulus delivery methods. Standard CRT stimulation was used (40 degree visual field) and wide field multifocal ERG using LCD projection (90 degree visual field). Recordings were performed on each system on two different occasions. A 15 bit m-sequence was used with recordings segmented into 16 segments of 30 seconds. Recordings were made using DTL electrodes. Concentric ring analysis was performed and the Coefficient of Repeatability (COR) was calculated for each ring.

Results: P1 Amplitudes: CRT produces COR values which vary from 25nV for the central element to 8nV for the mid-peripheral ring. LCD projection gives COR values which vary from 21nV for the central element to 10nV for the mid-peripheral ring..

P1 Latency: COR values ranged from 0.9msec to 1.7 msec for both CRT and LCD stimulus delivery methods.

Conclusions: The Coefficient of Repeatability is a useful measure to quantify the test - retest variation in the multifocal ERG. LCD and CRT performance was comparable in this small pilot study.

Tuesday 23rd August

IS THE MULTIFOCAL ERG A VALID TEST OF MACULAR FUNCTION IN PATIENTS WITH CATARACT?

Dudgeon, S., Parks, S., Keating, D.
Tennent Institute of Ophthalmology, Gartnavel General Hospital, Glasgow

Purpose: It is often difficult to determine whether local multifocal ERG (mfERG) responses in patients with cataract are reflective of the area of interest or whether cataract mediated increases in forward and back scattered light have rendered these local responses too contaminated to be of value. This poses difficulty for investigators attempting to reliably assess the spatial integrity of responses in patients with cataract. To help solve this problem we have devised a simple test which could eventually help determine whether mfERG is useful in assessing macular function of patients with differing types and severities of cataract.

Methods: By modifying the mfERG stimulus to create areas of high and low sensitivity to scatter it should be possible to estimate the level of neighbouring scatter contributions on the local mfERG response. Seven healthy controls underwent a series of experiments using a fixed mfERG stimulus paradigm with an inactive 3rd and 4th ring. This inactive region was presented at three fixed luminance levels (white, grey and black). The amplitude of surrounding active rings (2 and 5) was measured and compared for normal stimulation and at these fixed luminance levels

Results: There was on average a 20% decrease in response amplitude in local areas when the surrounding area was fixed at a high (white) luminance. At mean (grey) luminance response amplitudes displayed a less than 1% variation in responses and at low (black) luminance there was a 15% increase in response amplitudes.

Conclusions: The normative data we have collected indicates local mfERG responses are significantly affected by scatter from surrounding areas. We estimate at least 20% of each local response is reflective of activity outwith the area of interest. In patients with cataract it would be useful to perform mfERGs with inactive 3rd and 4th rings fixed at both black and white luminance levels in addition to full mfERG to eventually ascertain a cut-off point where the level of scatter is too high for mfERG to be a useful measure of macular function in these patients.

Tuesday 23rd August

MULTIFOCAL ERG IN VIGABATRIN INDUCED NEURORETINAL TOXICITY: A FIVE YEAR FOLLOW UP

Gonzalez, P., McCall, A., McQuiston, A., Keating, D., Dutton, G., Brodie, M., Parks, S.
Vision Science Research Group, University of Glasgow

Purpose: To decide if peripheral neuro-retinal toxicity in people with epilepsy on vigabatrin (VGB) is best monitored subjectively using visual fields or objectively using the wide field multifocal electroretinogram (WF mfERG).

Methods: A long term longitudinal study is ongoing to objectively assess the progression of neuro-retinal toxicity associated with VGB therapy at the Epilepsy Unit, Western Infirmary, Glasgow. 180 patients have been assessed so far, 51 of whom have had repeat assessments. These patients have been placed into four groups, current VGB, ex-VGB, other GABA-ergic, GABA naïve. Patients were matched for age, sex, duration of epilepsy and seizure control. All patients had WF mfERGs, logMar visual acuity, colour vision assessment, visual fields (static perimetry) and electroretinograms (ERGs) performed. In addition visual quality of life and epilepsy-related quality of life were assessed using questionnaires VFQ-25 and QOLIE-31 respectively.

Results: The difference in P1 latency between central and peripheral responses on WF mfERG is the best correlation with visual field defects, 97.5% sensitivity and 95% specificity. There is little difference between the groups in visual acuity, colour vision and ERG results. The questionnaires show people on VGB have a more negative change in their QOLIE-31 than the other groups whereas VFQ-25 change in the VGB group is similar to other groups.

Conclusions: The difference in P1 latency between central and peripheral responses on WF mfERG is the best correlation with visual field defects and is a good way to monitor progressive visual dysfunction in people on VGB.

ASSESSMENT OF CONTRAST SENSITIVITY IN INFANTS AND CHILDREN: A NOVEL TEST USING STEADY-STATE VISUAL EVOKED POTENTIALS (SSVEPS)

Calvert, J.[1, 2], Bradnam, M.[1, 3], Manahilov, V.[2], Hamilton, R.[1, 3], McCulloch, D.[2], Dutton, G.[1, 2, 3]

[1]Yorkhill Division NHS Greater Glasgow, [2]Glasgow Caledonian University, [3]University of Glasgow

Purpose: Children with neurological impairment often have visual dysfunction, including reduced contrast sensitivity (CS). However, a lack of co-operation or developmental delay can make subjective testing slow and inaccurate. We have developed an automated, objective contrast sensitivity test using ssVEPs which can assess vision in this difficult to test group. In the present study we measured contrast thresholds in a pilot group of normal children using the VEP test as well as age-appropriate psychophysical tests.

Methods: The rationale for our technique is to acquire the most important information as quickly as possible, before the child loses co-operation. This is accomplished by real-time analysis of the individual's ssVEP which determines the subsequent contrast levels to be presented. The stimulus presentation technique is based on an adaptive staircase method, usually used in psychophysical experiments. We assessed contrast thresholds in a group of infants and children using our VEP test as well as age-appropriate psychophysical tests (Hiding Heidi, Lea low contrast symbols, PC based psychophysical staircase technique, F.A.C.T sinewave grating chart and the Pelli-Robson chart).

Results: Contrast thresholds were reached in less than three minutes, with the threshold estimates being comparable to psychophysical estimates.

Conclusions: The use of ssVEPs, combined with sensitive objective signal detection and a staircase stimulus presentation is a rapid and valid strategy for determining contrast sensitivity. The VEP technique has proved practical and valid in a pilot study and we can continue to collect developmental norms for clinical use.

This work is funded by the Scottish Executive Chief Scientist Office Grant Number: CZB/4/247

Tuesday 23rd August

MULTIFOCAL ERG: LESSON 1

Brown, M., Hagan, R., Fisher, A.
Clinical Engineering Dept. and Clinical Eye Research Centre, Royal Liverpool University Hospital, Liverpool

Purpose: To explain the very basics of multifocal recording to enable an understanding of the some of the advantages, shortcomings and difficulties of the technique.

Summary: Considerable mystique surrounds the recording and signal extraction methods of multifocal ERG and VEP, with much obscure mathematical jargon to intimidate the newcomer. In fact the methods are not conceptually difficult, and I will present here a non-mathematical explanation of how the responses to each segment are separated and averaged.

There are many factors which influence the resulting traces for each segment: these include noise, artefact, recording bandwidth, artefact rejection, stimulation rate, stimulation sequences, light scatter, scaling, non-linear responses of the retina and of individual retinal segments, as well as interactions and complications arising from the type of light stimulator used. Also there are constraints imposed by the temporal stimulation patterns and signal extraction techniques.

I hope that my simple explanation of the basic technology will give confidence to new and potential users of the mfERG/VEP in its various forms, and allow them to understand the likely impact of changes in the above parameters.

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13:30 – 15:00 **ORAL PRESENTATIONS II**
Chairwoman: Dorothy Thompson, Great Ormond Street Hospital, London

13:30 – 13:45 DIAGNOSTIC VALUE OF THE EOG
Malcolm Brown *(Liverpool, UK)*

13:45 – 14:00 MFERG IN THE STUDY OF RADIAL OPTIC NEUROTOMY
Ann McQuiston *(Glasgow, UK)*

14:00 – 14:15 MULTIMODAL IMAGING USING THE COMBINED SLO/OCT AND MFERG
Sinead Dudgeon *(Glasgow, UK)*

14:15 – 14:30 WIDE FIELD MULTIFOCAL ELECTRORETINOGRAPHY IN THE ASSESSMENT OF EYES WITH RETINAL VEIN THROMBOSIS
Fiona Dolan *(Glasgow, UK)*

14:30 – 14:45 FUNCTIONAL DISTURBANCES OF THE RETINA IN ARTERIAL HYPERTENSION
Angelika Shamshinova (*Moscow, Russia*)

14:45 – 15:00 THE INFLUENCE OF LATITUDE ON VIGABATRIN INDUCED NEURORETINAL TOXICITY
Pedro Gonzalez *(Glasgow, UK)*

Tuesday 23rd August

DIAGNOSTIC VALUE OF THE EOG

Brown, M., Hagan, R., Fisher, A.
Clinical Engineering Dept, and Clinical Eye Research Centre, Royal Liverpool University Hospital, Liverpool

Purpose: To review the value of the EOG in clinical diagnosis.

Summary: The EOG test is sometimes questioned as having doubtful value, or diagnostic accuracy, particularly when used in conjunction with the full field ERG, when it often merely agrees with the ERG result. Here we review the results of EOG tests performed for reasons of clinical investigation to identify those cases where the EOG result was abnormal but the ERG was normal, to see if the EOG results materially added to the understanding of the cases, and to identify those cases in which an EOG test should be requested.

Methods: EOG/ERG tests were conducted to ISCEV protocols. EOG responses were declared subnormal if Arden ratios of less that 1.7 were found and ERG responses were declared normal if the dark adapted B-wave amplitude was greater than 250uV. We have classified these cases by 'provisional diagnosis' since the decision whether to perform an EOG must usually made at this stage. In our clinic the EOG is performed before the ERG to avoid prior dark adaptations affecting the EOG result.

Results: Abnormal EOG in the presence of normal ERG was found in 80 cases as referred with provisional diagnoses as follows: Best's disease (9), adult vitelliform dystrophy (3), Stargardt's macular dystrophy (8), macular dystrophy non-specific (9), retinitis pigmentosa (11), family history of RP (9), Behcet's disease (3), 'elderly' (10), other (18).

Conclusions: 80 cases were identified where the EOG results were abnormal in the presence of a normal ERG. Only 9 of these had been suspected of Best's disease. Using ISCEV guidelines the other 71 cases would not have had EOG tests performed whereas some had important retinal pathology identified solely by the EOG. Perhaps the most striking examples are the families investigated for RP, in which only the EOG was abnormal in otherwise symptom free patients.
The above figures did not include those cases in which the ERG and EOG were both considered abnormal, or both considered normal. In these situations the EOG result might support the ERG results in equivocal cases. Neither do we include those cases where the EOG is normal and the ERG abnormal.

Tuesday 23rd August

WIDE FIELD MULTIFOCAL ERG TO STUDY RADIAL OPTIC NEUROTOMY FOR CENTRAL RETINAL VEIN OCCLUSION

McQuiston A., Parks S., Keating, D., Muquit, M., Murdoch, J.
ElectroDiagnostic Imaging Unit, Gartnavel General Hospital, Glasgow

Purpose: A pilot study to investigate the effect of pars planar vitrectomy (PPV) and radial optic neurotomy (RON) for central retinal vein occlusion (CRVO) using the WF-mfERG.

Methods: Five patients with CRVO were recruited to undergo PPV and RON under standard conditions. Four were defined as ischaemic (I-CRVO) and one non–ischaemic (NI-CRVO) based on Hayreh's classification. The group was matched for age and sex to a group of five I-CRVO and five NI-CRVO controls. WF-mfERG responses were recorded pre-operatively and at one month, three months and 12 months post-operatively. All patients underwent the standard investigations of the surgical group.

Results: Five patients underwent surgical intervention for CRVO (4 I-CRVO and 1 NI-CRVO). There was no significant improvement in implicit timing of responses or P1 amplitude following PPV and RON for I-CRVO. The implicit timing worsened by 5ms for the NI-CRVO patient, resolving to pre-operative levels at six months post-operatively.

Conclusions: In I-CRVO, PPV and RON did not result in any significant improvement in P1 amplitude or implicit timing of responses using the WF-mfERG. In NI-CRVO, the control group demonstrated that P1 amplitudes and implicit timings may improve without surgical intervention.

MULTIMODAL IMAGING WITH THE COMBINED SLO/OCT AND MULTIFOCAL ERG

Dudgeon, S., Parks, S., Keating, D.
Tennent Institute of Ophthalmology, Gartnavel General Hospital, Glasgow

Purpose: To present a new high resolution imaging technique combining the modalities of scanning laser ophthalmoscope (SLO), optical coherence tomography (OCT) and multifocal ERG (mfERG) to allow simultaneous structural and functional assessment of the macula without compromising the recording quality of the individual components.

Methods: A combined SLO/OCT scanner was modified to include an organic light emitting diode (OLED) display within the optics of the system to provide the capacity for simultaneous multifocal ERG recording and SLO/OCT imaging of the macula. The OLED display has a maximum luminance of 820 cd/m^2 and allows high frequency mfERG recording of up to 85Hz with a rapid 1ms rise time. Patients with various macular conditions were assessed with combined SLO/OCT/micro mfERG in addition to conventional mfERG and the results compared.

Results: Our results so far indicate the spatial and temporal characteristics of micro mfERG recordings show increased sensitivity compared with those of conventional mfERG. This enhanced resolution may allow macular function to be assessed with greater accuracy than was previously possible.

Conclusions: While this multimodal imaging technique is at an early stage of development, it appears to be a viable technology providing improved resolution and greater accuracy of macular assessment. The ability to create combined structural and functional macular maps will give a new insight into many pathologies and SLO/OCT/micro mfERG may eventually supersede conventional mfERG in the assessment of various macular conditions.

WIDE FIELD MULTIFOCAL ELECTRORETINOGRAPHY IN THE ASSESSMENT OF EYES WITH RETINAL VEIN THROMBOSIS

Dolan, F.M.[1], Parks, S.[1], Keating, D.[1], Dutton, G.N.[1] and Evans, A.L.[2]

[1]*Tennent Institute of Ophthalmology, Gartnavel General Hospital, Glasgow*

[2]*Dept of Clinical Physics and Bio-engineering, Southern General Hospital, Glasgow*

Purpose: To determine the wide field multifocal ERG (WF-mfERG) responses in eyes with retinal vascular disease caused by central, branch and hemi retinal vein occlusions (CRVO, BRVO and HRVO).

Methods: WF-mfERG responses were recorded from the eyes of 95 patients diagnosed with RVT within 3 months of the acute event using a custom-built system. 56 patients with CRVO, 31 patients with BRVO and 8 patients with HRVO were included. The WF-mfERG first order responses, namely the P1 amplitude and the P1 latency were recorded in the affected eyes and compared to the responses in the 'normal' fellow eye and also compared to age-related normative data (5-95% confidence limits).

Results: The WF-mfERG P1 amplitude was significantly reduced and the P1 latency was delayed in the affected eyes. There was a significant difference in both the P1 amplitude and the P1 latency in the affected eyes compared to the unaffected fellow eyes. Also, a marked percentage of the WF-mfERG responses in the affected eye fell outside the normal confidence intervals not only in the affected eyes but also in the unaffected fellow eyes.

Conclusions: Retinal vein occlusion can cause considerable disruption to the integrity of the retina and can significantly affect the function of the retina due to ischaemia. WF-mfERG is a non-invasive, electrodiagnostic test which generates immediate results facilitating objective assessment of retinal function. It can be used to perform serial measurements and is well tolerated by patients. Results from this study suggest that WF-mfERG has the potential to be a useful investigative tool in the clinical setting.

Tuesday 23rd August

FUNCTIONAL DISTURBANCES OF THE RETINA IN ARTERIAL HYPERTENSION

Shamshinova A., Arakelyan, M.A.
Moscow Helmholtz Institute of Eye Diseases, Russia

Purpose: To study electroretinographic and psychophysical symptoms in arterial hypertension.

Methods: 72 patients with stages I, II and III of arterial hypertension were examined. A topography of contrast and colour sensitivity of the retina in the area of 1°, 5° and 10° from macula was analyzed using an original computer method to estimate a function of ON and OFF channels. A diagram of the reaction time to wavelength, hue and saturation was graphed for each test point. ERG was performed in standard methods (full-field, flicker, oscillatory potentials) and chromatic ERG to red, green and blue stimuli.

Results: Contrast and colour sensitivity was mostly diminished in 5° and 10° from the macular area in patients with stage I. Gradual progression of disturbances was observed in stages II and III in 5° and 10° from the macular area, as well as in the central part. Of particular interest are local focuses of prolonged reaction time, which did not depend on the fundus changes and could even exist in the absence as well as in the presence of pathological findings. Full-field ERG recordings showed reduction or increase in b-wave amplitude and prolonged latency of the b-wave, which was probably defined by various symptoms of hypertensive retinopathy in stages II ($p<0.027$) and III ($p<0.048$). Chromatic ERG recordings to red stimulus showed a decrease in b-wave amplitude in all stages ($p<0.005$), as an indicator of pre-clinical hypertensive retinopathy. Chromatic ERG recordings to green and blue stimuli showed decrease or increase in b-wave amplitude, prolonged latency of the b-wave in stages II and III, which indicates early pathological processes in paracentral area and may be a result of excitotoxic processes in retinal tissue. Amplitude of flicker ERG was changed significantly in stages II and III as a marker to distinguish disturbances in the cone system. The oscillatory potentials were of abnormal configuration, the peak latencies were prolonged in the stage III as a result of inner retinal damage, reflecting microcirculatory changes that lead to ischemia and hypoxia.

Conclusions: Even though patients rarely develop clinically apparent fundus changes, our findings are evidence that eye still remains a target organ in arterial hypertension. Presented ERG and psychophysical symptoms may have a future potential use for an early diagnostic and prognostic approach and introduce a new concept on pathogenesis of arterial hypertension.

Tuesday 23rd August

THE INFLUENCE OF LATITUDE ON VIGABATRIN INDUCED NEURO-RETINAL TOXICITY

Gonzalez, P.
Vision Science Research Group, University of Glasgow

Purpose: VGB, an antiepileptic drug is associated with visual field defects (VFD). The incidence of VFD varies hugely (0.14% to 80%) between different studies. The main contributing factor is neuro-retinal toxicity, though the pathogenesis of this process is poorly understood. Previous studies have not shown any correlation with age, sex, load, type of epilepsy or any other factor. A recent paper by Izumi et al suggests that light exposure is important in the development of retinal lesions. Differences in light exposure due to geography may influence the incidence of VFD.

Methods: A literature review examined the incidence of all visual defects reported. The incidence was taken to be the highest rate of abnormality noted of three parameters: visual fields, electroretinograms or multifocal electroretinograms. A long term longitudinal study is ongoing in Glasgow and these results were also included. Incidence rates were compared to latitude and light levels.

Results: Twenty four studies were reviewed. Latitude was determined for each city where the study was done. There was no relationship between latitude and incidence of visual defects. However once light levels were calculated for each region then there does seem to be a linear relationship between higher incidence of visual defects in areas exposed to higher light levels.

Conclusions: There seems to be no relationship between latitude and incidence of visual defects associated with VGB. There however seems to be a relationship between light levels and incidence of visual field defects associated with VGB. Further study need to be done investigating this phenomenon.

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NOTES

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HOST LECTURE
UNDERSTANDING THE MFERG

David Keating
University of Glasgow

The multifocal ERG is a powerful addition to our range of tools to investigate retinal function. The technique gives local information on retinal processing and provides an insight into both linear and non-linear dynamics of visual processing. Since the introduction of multifocal ERG by Erich Sutter in the early 1990s, many people have asked key questions such as: how local is the multifocal response? How does the multifocal ERG compare to the standard Ganzfeld ERG? How important is the stimulus presentation time and what length of sequence should be used? This presentation will attempt to answer these questions in a structured manner with the presentation structured in four parts.

Part 1: The basis of multifocal ERG will be presented; this will include the generation of the m-sequences and the cross correlation process. Sequence selection will also be discussed.

Part 2: The Factors which influence the multifocal ERG
The recording parameters such as stimulus delivery method, amplifier filter characteristics and speed of delivery will be described.

Part 3: The multifocal ERG response.
The sub-components that contribute to the multifocal ERG waveform will be described together with experimental procedures used to estimate the local and lateral components. The relationship to the Ganzfeld ERG will be introduced.

Part 4: Clinical Investigation.
The clinical usefulness of multifocal ERG with specific clinical examples will be presented.

BriSCEV III
Glasgow 22nd – 23rd August 2005

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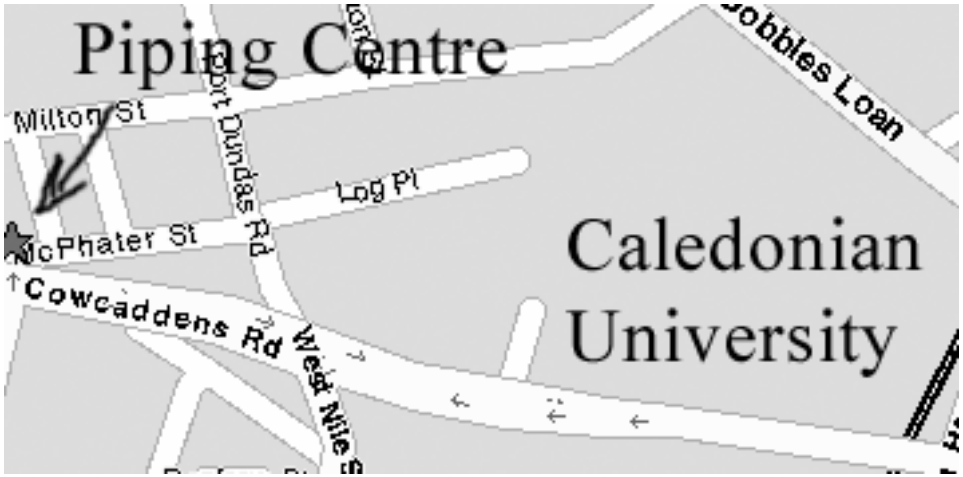
Social Programme – Monday 22nd August

19:00 Reception at Piping Centre, 30-34 McPhater Street, Cowcaddens
(Piper and Champagne)

19:30 Dinner

21:00 Traditional Ceilidh
(Ceilidh band – Bahookie!)

The piping centre is approximately 300m west of the entrance to Caledonian University on Cowcaddens Road. If you have problems with the directions, listen for the piper!



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