

A comparative study of visual evoked potentials with automated Humphrey visual fields in patients with primary open angle glaucoma

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Abstract

Primary open angle Glaucoma (POAG) is a chronic, progressive optic neuropathy caused by a group of ocular conditions which lead to damage of the optic nerve with loss of visual function. Various modalities are available to detect the damage to the optic nerve head and the retinal nerve fibre layer. Traditionally Visual Evoked Potentials (VEP) has been used to test optic nerve and Humphrey Visual Field Analyser with results favouring one over the other. Hence a study was conducted comparing parameters of standard VEP with the indices of Humphrey Visual Field Analyser in patients of POAG.

Material and Methods: A group of 30 diagnosed cases of primary open angle glaucoma. Selected patients were then taken up for Visual Field Analysis and VEP recordings using VEP systems as per the protocol of International society for clinical electrophysiology of vision (ISCEV). Visual field analysis was performed on Humphrey Visual Field Analyser II – series. Patient's pupil size was noted and the test selected was central 30-2.

Results: Patients belonged to the age group of 50-54 years. About 2/3 of patients were males & about 1/3 of patients were females. Of the 60 eyes 34 eyes (56.6%) had delayed P₁₀₀ latency whereas 26 eyes (43.4%) showed GHT outside normal limits. Mean of MD was more (3.54) when the GHT was the deranged parameter and less when the deranged parameter was P₁₀₀ latency (2.63).

Conclusion: VEP is affected in POAG. As an independent parameter more eyes had delayed P₁₀₀ values when compared to GHT. In 16/60 eyes (26.6%) the P₁₀₀ latencies were affected before GHT changes in Humphrey visual fields. In this study P₁₀₀ latencies were statistically significant when compared to MD & GHT index of Humphrey Perimeter.

Keywords: Glaucoma hemifield test, Humphrey visual field analysis, Primary open angle glaucoma, P₁₀₀ latency, Visual evoked potentials.

Introduction

Glaucoma is a chronic, progressive optic neuropathy caused by a group of ocular conditions which lead to damage of the optic nerve with loss of visual function and the most common risk factor known is raised intra-ocular pressure (IOP).¹ Primary open angle glaucoma (POAG) is the second leading cause of visual loss in the world which has a multifactorial aetiology and is thought to have a hereditary predisposition. It is generally a bilateral disease, although its severity may be asymmetric in the two eyes. It is generally an asymptomatic and progressive disease.²⁻⁴ The Vellore Eye Survey (VES) reported a prevalence of 0.41% in the 30 to 60 year age group, whereas the Andhra Pradesh Eye Diseases Study (APEDS) estimated the prevalence in the urban population to be 2.56% in those aged 40 years and older.⁵ Various modalities are available to detect the damage to the optic nerve head and the retinal nerve fibre layer. However all these are structural defects and do not reflect the functional outcome.⁶ Traditionally VEP has been used to test optic nerve diseases like multiple sclerosis but has been employed to test the visual function in POAG. There have studies comparing VEP with visual fields in particular with the indices of Humphrey Visual Field Analyser with results favouring one over the other.^{7,8} Hence a study was conducted comparing parameters of standard VEP with the indices of Humphrey Visual Field Analyser in patients of POAG.

Aim of the study was to find out if VEPs (Visual Evoked Potentials) are affected in Primary Open Angle Glaucoma and if so to what an extent. To correlate these

findings with central 30-2 threshold Automated Humphrey Visual Fields.

Materials and Methods

A group of 30 diagnosed cases of primary open angle glaucoma attending for investigation, treatment and follow-up at the Ophthalmic OPDs of a tertiary eye care centre were enrolled for this the study. The diagnosis was based on gonioscopy, intraocular pressure evaluation by applanation tonometry and optic disk evaluation by fundoscopy.

Ethical committee clearance was taken prior to the study. Informed consent was received from all subjects enrolled in the study. The inclusion criteria were patients of POAG with best corrected visual acuity 6/6.

Exclusion Criteria

- i. Post op patients whether of glaucoma, cataract or both.
- ii. Any glaucoma other than POAG.
- iii. Uncooperative patients.
- iv. Patients with any neurological disorder.
- v. BCVA less than 6/6.

Selected patients were then taken up for Visual Field Analysis and VEP recordings. These tests were performed on different days so as to prevent any interference of one investigation on the other.

VEP Recording Procedure

VEPs are electrical signals generated at the visual cortex in response to visual stimulation. Patterned reversal VEP with 64 checker board done was with Medelec

Synergy, VEP systems (software version-10-oxford medelec) as per the protocol of International society for clinical electrophysiology of vision (ISCEV). Patients were requested to come with a dry hair without applying any hair oil as the same interferes with the electrode contact. The subjects under examination were seated in a semi dark, acoustically isolated room, in front of the display that was surrounded by a uniform field of luminance of 5 cd/m². The subjects were informed on the type of examination and its diagnostic uses. No mydriatic or miotic drug was used prior to the procedure.

A checker size of 64 was selected and the smallest size fixation spot on the monitor was used. Full-field stimulation performed monocularly, utilizing a high-contrast 70-100% (>50%). Pattern stimulation was black-and-white checkerboard pattern, at a reversal rate of 4/s or less. The visual stimuli were checkerboard patterns (contrast expressed as Lmax 2 Lmin/Lmin 1 Lmax was 110 cd/m²) generated on a TV monitor and reversed with 80% mean luminance. The visual acuity of the patient recorded and the patient was optimally refracted for the viewing distance of the screen.

Testing circumstances was standardized, including seating distance of 70-100 cm from the monitor screen, giving a check size of approximately 30 seconds of visual angle. Fatigue may affect the subject's ability to maintain focus on close objects. To avoid this effect, the subject was not placed closer than 70cm to the stimulus. VEP testing was performed at usual ambient light levels. The interelectrode resistance was kept below 5kV. The bioelectric signal was amplified (gain 20 000), filtered (bandpass 1±100 Hz) and averaged (200 events free from artefacts were averaged for every trial. The analysis time was 250 ms.

One eye was checked at a time with the right eye being the first. Monocular stimulation was performed by occluding the other eye. Monocular stimulation was used to avoid masking of a unilateral conduction abnormality. Care was taken to have the patient in a comfortable, well supported position to minimize muscle and other artefacts. Eye position was monitored throughout the test.

The scalp electrodes placed relative to bony landmarks, in proportion to the size of the head, according to the International 10/20 system. Standard silver-silver chloride surface electrodes the active electrode was placed on the scalp over the visual cortex at Oz with the reference electrode at Fz. The earlobe was used for ground electrodes. The analysis time (sweep duration) was 250ms.

The transient VEP was characterized by several waves with 3 peaks, and it appears after 75, 100 and 145ms. These peaks had negative (N75), positive (P₁₀₀) and negative (N₁₃₅) polarity, respectively. Two responses were recorded.

The parameter taken for the study was P₁₀₀ latency alone. Since the amplitude is variable between eye to eye and between person to person, the same was not considered for analysis.^{9,10}

Visual Field Analysis

A total of 30 diagnosed cases of Primary Open Angle Glaucoma (60 eyes) were studied. Visual field analysis was performed on Humphrey Visual Field Analyser II – series Medelec 45- Carl Zeiss Medelec Patient's pupil size was noted, and the test selected was central 30-2 & the strategy was SITA Fast. Patient was tested monocularly after occluding one eye and after proper near correction.

The parameters were as follows - Fixation monitoring- Gaze track/ Blind spot, Fixation target- Central, Stimulus size- goldman size III, Stimulus color- White, Stimulus intensity -(Brightness) white on white, Background illumination-31.5 ASB

The index of the Humphrey perimeter taken into consideration was Mean Deviation (MD) of global indices & the Glaucoma Hemifield Test (GHT). The results of Visual Evoked Potentials & Humphrey Visual Fields were compared in terms of delayed P₁₀₀ latency, Glaucoma Hemifield Test (GHT) & Mean Deviation respectively. All the data were compiled & analysed statistically.

Results

The compilation & analysis of the results were done. The maximum number of patients belonged to the age group of 50-54 years (43.2%). About 2/3 of patients (63.4%) were males & about 1/3 of patients (36.6%) were females. (Table 1)

Table 1: Age and Sex wise distribution

| Age (Years) | Sex | | Total (%) |
|-------------|------------|------------|------------|
| | Male (%) | Female (%) | |
| 50 – 54 | 8 (26.67) | 5 (16.67) | 13 (43.33) |
| 55 – 59 | 4 (13.33) | 1 (3.33) | 5 (16.67) |
| 60 – 64 | 3 (10) | 2 (6.67) | 5 (16.67) |
| 65 – 69 | 3 (10) | 2 (6.67) | 5 (16.67) |
| 70 – 74 | 1 (3.33) | 1 (3.33) | 2 (6.67) |
| Total | 19 (63.33) | 11 (36.67) | 30(100) |

Table 2: Delayed P₁₀₀ latency of visual evoked potentials was represented

| GHT | P ₁₀₀ IT | | Total |
|----------|---------------------|------------|------------|
| | Abnormal | Normal | |
| Abnormal | 18 (30) | 10 (16.66) | 28 (46.67) |
| Normal | 16 (26.67) | 16 (26.67) | 32 (53.33) |
| Total | 34 (56.67) | 26 (43.33) | 60 (100) |

- Of the 60 eyes 34 eyes (56.6%) had delayed P₁₀₀ latency whereas 26 eyes (43.3%) showed GHT outside normal limits.
- Eighteen out of the 60(30.0%) eyes had a derangement of both the parameters. Ten out of 60 eyes (16.6%) had deranged fields but the VEPs were not affected.
- 16 eyes out of 60 had normal VEPs as well as GHT within normal limits. There are 16 eyes out of the study group of 60 eyes which have normal P₁₀₀ latencies

Table 3: Mean of mean deviation (MD)

| S. No. | Group | Mean MD |
|--------|--|---------|
| 1. | GHT outside normal limits and delayed P ₁₀₀ latencies | 4.6 |
| 2. | GHT outside normal limits and normal P ₁₀₀ latencies | 2.63 |
| 3. | GHT within normal limits and normal P ₁₀₀ latencies | 1.3 |
| 4. | GHT outside normal limits and normal P ₁₀₀ latencies | 3.54 |

It may be seen that when both the parameters are deranged the mean MD is also the maximum. Mean MD has been the least when both the parameters were within normal limits. But mean MD is more (3.54) when the GHT is the deranged parameter and less when the deranged parameter is P₁₀₀ latency (2.63). It indicates that MD is more affected when fields are affected.

Discussion

The purpose of this study was to find out if VEP's are affected in patients with primary open angle glaucoma and if so to what an extent & to correlate these findings with central 30-2 threshold automated Humphrey visual fields.

The parameter considered in VEP recordings was delayed P₁₀₀ latency. In the Humphrey visual field, the parameters considered were mean deviation (MD) of global indices and Glaucoma Hemi field Test (GHT).

Age & Sex Distribution

The maximum number of patients belonged to the age group of 50-54 years [13/30 patients (43.2%)]. This data is in consonance with the known indices of POAG. About 2/3 of patients 19/30 (63.4%) were males & about 1/3 of patients 11/30 (36.6%) were females. Due to the sample size no comment can be offered on the sex distribution of the study group.

Delayed P₁₀₀ Latency and GHT outside Normal Limits

Of the 60 eyes 34 eyes (56.6%) had delayed P₁₀₀ latency whereas 26 eyes (43.3%) showed GHT outside normal limits. As an independent parameter more eyes had delayed P₁₀₀ values when compared to GHT. In this study the percentage of eyes which had delayed P₁₀₀ was more than 50% and it is to be noted that these eyes had a vision of 6/6.

Comparative Analysis of P₁₀₀ Latency and GHT

There are four situations to be analysed. It may be seen that the first three presentations are in consonance with what has been described in literature.

a. GHT outside Normal Limits and Delayed P₁₀₀ Latencies

Eighteen out of the 60(30.0%) eyes had a derangement of both the parameters. This indicates that 30% of the eyes with a vision of 6/6 at the time of examination had deranged VEP as well as GHT outside normal limits.¹¹

b. GHT outside Normal Limits and Normal P₁₀₀ Latencies

Ten out of 60 eyes (16.6%) had deranged fields but the VEPs were not affected. It is known that fields are the first

to be affected.¹² Hence these findings are in consonance with the facts reported in literature.

c. GHT outside Normal Limits and Normal P₁₀₀ Latencies

16 eyes out of 60 had normal VEPs as well as GHT within normal limits. These 26.6% of eyes have been those in whom the disease process has not taken its toll. These findings are in corroboration with the findings of Caiping Hu et al¹³ who did a comparative evaluation of Humphrey perimetry and the multi-channel pattern visual evoked potentials in the assessment of central visual function in primary open angle glaucoma. The multi-channel PVEPs demonstrated a low detection rate compared with Humphrey perimetry in the early glaucoma, absolute latency and field loss were correlated in the late stage of glaucoma, and absolute amplitude and field loss were not correlated.

d. GHT within Normal Limits and Delayed P₁₀₀

It is this category which is interesting. There are 16 eyes out of the study group of 60 eyes which have normal P₁₀₀ latencies but the fields have already been affected. This has also been corroborated by Lan et al,¹⁴ who studied the significance of electrophysiology & combination of automated perimetry in the early diagnosis of POAG. The latency of PVEP had positive correlation with visual fields indices. They had concluded that in the earlier stage of POAG before visual field defects could be found, PVEP would be a more sensitive indicator even though IOP was normal. Humphrey automated perimetry were very useful indicators after early stage. Early abnormality of VEP before visual field defects has also been detected but with colour PVEP by Yang H, Jiang Y & Wu Z. (1996)¹⁵ & Yi-Hao Shih, Zhu-Jing Huang & Ching-E Chang (1991).¹⁶

It may be seen that when both the parameters are deranged the mean MD is also the maximum. In fact in this group, the max MD has been 21.42.

Mean MD has been the least when both the parameters were within normal limits. Both these findings are understandable. But mean MD is more (3.54) when the GHT is the deranged parameter and less when the deranged parameter is P₁₀₀ latency (2.63). It indicates that MD is more affected when fields are affected. This corroborates the findings of Parisi et al.¹⁷

Conclusion

VEP is affected in POAG. Of the 60 eyes 34 eyes (56.6%) had delayed P₁₀₀ latency whereas 26 eyes (43.4%) showed GHT outside normal limits. As an independent parameter more eyes had delayed P₁₀₀ values when compared to GHT. In 16/60 eyes (26.6%) the P₁₀₀ latencies were affected before GHT changes in Humphrey visual fields.

Mean of MD was more (3.54) when the GHT was the deranged parameter and less when the deranged parameter was P₁₀₀ latency (2.63). This indicates that MD is more affected when fields are affected. In this study P₁₀₀ latencies were statistically significant when compared to MD & GHT index of Humphrey Perimeter.

In this study delayed P₁₀₀ latencies were seen in more than ½ of the eyes. Delayed P100 was more than GHT outside normal limits. In ¼ of the cases VEP was affected even before GHT turned abnormal. P₁₀₀ was statistically significant when compared with MD & with GHT of Humphrey Visual Field.

Conflict of Interest: None.

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