

Comparative evaluation of Octopus semi-automated kinetic perimeter with Humphrey and Goldmann perimeters in neuro-ophthalmic disorders

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Purpose: The aim of this study was to compare the performance of Octopus 900(OVF) kinetic module with Goldmann perimeter (GVF) and Humphrey 750i (HVF) perimeters in neuro-ophthalmic disorders. **Methods:** During this prospective observational cross-sectional study, 17 patients (26 eyes) with neuro-ophthalmic disorders underwent visual field examination on the three perimeters. Field defects on OVF were matched with HVF and GVF for the number of quadrants involved. An unmasked observer, and a masked observer (unaware of the clinical diagnosis) were made to separately diagnose the type of field defects on all three fields for the same patient. The pattern of field defect on OVF was compared with GVF and HVF field defects for both observers. **Results:** When OVF was compared with HVF and GVF, 88% eyes correctly matched for normal or abnormal visual fields, while quadrant-matching was 80% and 89% respectively. For the unmasked observer, the pattern of field defects on OVF was similar to HVF and GVF in 58% and 65% eyes respectively while for a masked observer, it was 54% and 62%. Central and paracentral scotomas showed unmatched fields when OVF was compared with HVF and GVF. When these patients were excluded, sensitivity of OVF increased to 95%. **Conclusion:** Clinical correlation aids in better characterisation of a field defect. All 3 perimeters are concurrent in the pattern of field defects for non-central defects. However, the default protocol on OVF may not be enough to demarcate the central and para-central scotomas. Development of a customised protocol for the assessment of central and centrocecal field defects increases the accuracy of OVF.

Key words: Goldmann, humphrey, neuro-ophthalmology, octopus, perimetry

Perimetry is one of the most commonly used investigations in neuro-ophthalmology. It aids in the diagnosis and localisation of lesions along the visual pathway, monitors progression and recurrence of diseases and guides in treatment of various neuro-ophthalmological conditions.^[1]

Several different techniques are available for visual field testing including confrontation (at the bedside), tangent screen, Goldmann kinetic perimetry, and automated static perimetry. Automated perimeters are mainly static and are widely available and could be less time-consuming depending on the strategy used. However, static perimetry requires greater patient concentration, is less efficient in delineating complex lesions extending into the peripheral field, and localizing occipital lobe lesions.^[2,3] The most widely used device of this sort is the Humphrey perimeter.^[4]

The most widely used kinetic perimeter is the Goldmann perimeter. It is especially useful in the visual field assessment of patients with poor visual acuity, young children or severely restricted visual fields, patients with injuries of the posterior hemispheres of the brain,^[5] and in the certification of visual performance during driver license tests in some Western countries.^[6] It is often considered the gold standard as it demonstrates the peripheral as well as central defects, and

correlates better with activities of daily living.^[7] However, it requires a skilful perimetrist and is time-consuming.

Semiautomated kinetic perimetry (SKP), with the Octopus 900 provides the advantage of a kinetic perimeter in an automated method. The learning time is shorter and subsequent tests are presented in an identical manner. This aids standardization of serial examinations, the requirement for technical expertise reduces and intertest comparison becomes easier.^[8] Octopus 900 provides 90-degree full-field projection perimetry with a range of 47 decibels. It can perform both kinetic and static perimetry programmes. When used as an automatic test, pre-selected vectors are used. When used as a kinetic test, the vectors are chosen 'live' depending on the patient responses during the test. In the latter, the perimeter is being utilised in the same way as Goldmann kinetic perimetry.^[5] In SKP, the reaction time of the perimetrist is eliminated, thus the results are more reliable and stable.^[9]

In this study, the performance of kinetic mode of Octopus 900 was compared to the more commonly done Goldmann and Humphrey 750i perimeters in patients with neuro-ophthalmic disorders.

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Methods

This is a prospective cross-sectional observational study conducted on patients recruited from the neuro-ophthalmology clinic at our centre from January 2018 to June 2018. Informed consent for perimetry testing was obtained from all patients before enrolment into the study. Ethics committee approval was obtained, and this study was done according to the tenets of the Declaration of Helsinki.

Patients of age group 18–60 with a visual acuity of 6/24 or more in the eye being tested, who were willing to give consent and was able to understand and follow instructions for the tests were included in the study. Patients with visual acuity less than 6/24 or those who were too ill to perform the study were excluded. All the patients were assessed for visual acuity, pupillary reactions and underwent detailed posterior segment examination, and imaging studies where necessary, based on which a diagnosis was made.

After proper refractive correction, each patient underwent visual field examination on all the 3 perimeters namely, Octopus 900 Kinetic Perimeter (Octopus visual field) (Haag Streit, Switzerland), Goldmann Perimeter (GVF) (Inami, Tokyo, Japan) and Humphrey 750i Visual Field Analyzer (HVF) (Humphrey Instruments, Dublin, CA). All three tests were performed on the same day by a single examiner with short breaks in between, and in random order to avoid bias due to fatigue.

For Goldmann perimetry, two stimuli of the same intensity (1000 apostilbs) were used, but of different sizes (III4e, 4 mm² and V4e, 64 mm²). For delineating peripheral isopters, the test object was moved at a speed of approximately 3 degrees per second from non-seeing areas inward. To delineate scotomata and the blind spot, stimulus was moved from inside the scotoma outward. Blind spot was assessed using a size III4e target. A minimum of twelve vectors were assessed for the peripheral visual field.

For Octopus visual field (OVF), tests were done in the kinetic mode. The default protocol was used, with a stimulus size of V4e and III4e at the speed of 5 degrees/sec for isopter charting and a stimulus size of III4e with speed of 2 degrees/sec moved outward for blind spot charting.

For HVF, the 30-2 Swedish Interactive Thresholding Algorithm (SITA) Standard protocol was used where 76 points in the central 30 degrees of visual field and blind spot were tested using a stimulus of Goldmann size 3. Patients with fixation losses or false positive/false negative responses more than 20% on HVF was excluded from the study.

Comparison of results

Keeping in view that a stimulus size of III was used in HVF, only III4e isopters of kinetic perimeters were considered for comparison between the perimeters.

The unmasked observer initially classified the visual fields as normal or abnormal. The field defects on OVF were matched with those on HVF and GVF for the number of quadrants involved, and the pattern of field defects on all 3 perimeters were reviewed and classified by an unmasked observer. A masked observer who was unaware of the clinical diagnosis then reviewed the reports of all the 3 perimeters in random order to diagnose the pattern of

the field defect. The field defects were classified as central scotoma, centrocecal scotoma, hemianopia, quadrantanopia, sectoranopia, field constriction and blind spot enlargement. The pattern of field defect on OVF was compared with GVF and HVF field defects for both masked and the unmasked observer.

Statistical analysis

The results were statistically analyzed. Direct comparison of results was made for Goldmann, HVF and Octopus perimetry results using the statistical package SPSS version 19 (IBM SPSS Statistics, USA). Chi-square test was used to correlate detection of abnormalities in the Octopus visual field when compared to HVF and GVF separately. Cohen's kappa statistic was used to calculate agreement between the masked and unmasked observer assessing the field patterns. Kappa values range from 0 to 1. A value equal to or less than zero indicates no agreement. 0.01–0.20 signifies slight agreement, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 substantial, and 0.81–1.00 shows almost perfect agreement.^[10] Duration of test was compared between perimeters using unpaired *t* tests.

Results

A total of 26 eyes of 17 patients were included in the study. Some patients were tested unilaterally because of poor visual acuity in the other eye. Fourteen of the 17 patients were males. Mean age of the patients was 32 ± 7.4 years. Visual acuity of the patients ranged from 0.6 to 0 logMAR.

These patients had been diagnosed with traumatic optic neuropathy, chiasmal lesions, cortical infarcts, meningioma, ischemic optic neuropathy, secondary optic atrophy, toxic optic neuropathy, optic neuritis or papilledema [Table 1].

Octopus visual field versus HVF

When Octopus visual field was compared with Humphrey field, 23/26 eyes (88%) were correctly matched for normal or abnormal visual fields. The number of quadrants that matched between Octopus visual field and HVF was 80%. Nineteen eyes (73%) showed at least 3 matching quadrants in HVF and Octopus visual field.

For the unmasked observer, the pattern of field defects on Octopus visual field matched in 15/26 (58%) eyes when compared with HVF. For a masked observer, the pattern of field defects matched in 14/26 (54%) eyes on comparing Octopus visual field with HVF. The measure of agreement between unmasked versus masked observer for HVF versus Octopus visual field had a kappa value of 0.634.

Mean duration taken for the HVF test was 5.90 ± 1.40 min. and for OVF, it was 5.46 ± 1.12 min (*P* = 0.10).

Octopus visual field versus GVF

When Octopus visual field was compared with Goldmann field, 23/26 eyes (88%) were correctly matched for normal or abnormal visual fields. The number of quadrants that matched between Octopus visual field and GVF was 89%. Twenty-four eyes (92%) showed at least 3 matching quadrants in GVF and Octopus visual field.

For the unmasked observer, the pattern of field defects on Octopus visual field matched in 17/26 (65%) eyes when compared with GVF. For a masked observer, the pattern of field

Table 1: Clinical diagnosis and pattern of field defects in the three perimeters

Pt No.	DIAGNOSIS	HVF	GVF	OCTOPUS
1	LE TON	RE IN constriction with IN central scotoma	RE IN constriction with central scotoma	RE Normal field
2	LE TON	RE Temporal hemianopia	RE Temporal hemianopia	RE Temporal hemianopia
3	Chiasmal lesion	LE Temporal hemianopia	LE Temporal hemianopia	LE Quadrantanopia
4	Chiasmal lesion	RE ST Quadrantanopia LE ST Quadrantanopia	RE ST Quadrantanopia LE ST Quadrantanopia	RE ST constriction LE Blind spot enlargement
5	Sub-arachnoid haemorrhage	RE temporal hemianopia LE nasal hemianopia	RE temporal hemianopia LE nasal hemianopia	RE temporal hemianopia LE nasal hemianopia
6	Left sided clinoidal meningioma	RE temporal hemianopia LE nasal hemianopia	RE temporal hemianopia LE nasal hemianopia	RE temporal hemianopia LE nasal hemianopia
7	Right occipito-parietal cortical infarct	RE Nasal hemianopia LE Temporal hemianopia	RE Nasal hemianopia LE Temporal hemianopia	RE Nasal hemianopia LE Temporal hemianopia
8	RE TON	LE Temporal hemianopia	LE Temporal hemianopia	LE Normal field
9	Secondary Optic Atrophy (IIH)	RE Temporal hemianopia	RE Temporal hemianopia	RE Temporal hemianopia
10	Both eye toxic optic neuropathy	RE SN macular scotoma with ST quadrantanopia LE IT macular scotoma with blind spot enlargement	RE Inferior sectoranopia LE IT macular scotoma with blind spot enlargement	RE Blind spot enlargement LE Blind spot enlargement
11	Cerebrovascular accident	RE inferotemporal quadrantanopia LE inferonasal quadrantanopia	RE inferotemporal quadrantanopia LE inferonasal quadrantanopia	RE temporal sectoranopia LE inferonasal quadrantanopia
12	Recurrent Pituitary Adenoma	LE Temporal Hemianopia	LE Temporal Hemianopia	LE Temporal hemianopia sparing macula
13	Tuberculous meningitis	RE Temporal Hemianopia	RE ST quadrantanopia	RE ST quadrantanopia
14	Both eye Traumatic Optic Neuropathy	RE Temporal Hemianopia LE Temporal hemianopia	RE Temporal Hemianopia LE ST quadrantanopia	RE Temporal Hemianopia LE ST quadrantanopia with blind spot enlargement
15	Left PCA infarct	RE Temporal hemianopia LE Nasal hemianopia	RE Temporal hemianopia LE Nasal hemianopia	RE Temporal hemianopia LE Nasal hemianopia
16	Right occipito-parietal cortical infarct	RE Nasal hemianopia LE Temporal hemianopia	RE Nasal hemianopia LE Temporal hemianopia	RE Nasal hemianopia LE Temporal hemianopia
17	RE Optic Neuritis	RE ST macular scotoma	RE ST macular scotoma	RE Normal field

TON=Traumatic optic neuropathy, PCA=Posterior cerebral artery, IT=inferotemporal, IN=inferonasal, ST=superotemporal, SN=superonasal, IIH=Idiopathic Intracranial Hypertension, RE=Right eye, LE=Left eye

defects matched in 16/26 (62%) eyes on comparing Octopus visual field with GVF. The measure of agreement between unmasked versus masked observer for GVF versus Octopus visual field had a kappa value of 0.921. Duration of the GVF test was not calculated for every patient.

Figs. 1 and 2 show field defects of two patients on HVF, Octopus and GVF perimeters, respectively.

Discussion

Visual field examination is important for diagnosis, monitoring and functional assessment in neuro-ophthalmology. Among the 3 perimeters assessed in this study, HVF, followed by GVF are the more commonly performed tests. Goldmann kinetic perimeter is more useful in patients with poor visual acuity or severely depressed fields and in patients with trauma to the posterior hemispheres of the brain.^[5] However, its production ceased in 2007 and the kinetic module of Octopus perimetry has been gradually replacing the Goldmann perimeter.^[11]

Bjerre *et al.* studied 221 healthy volunteers including children and young adults, and reported the normative data

for visual field area (for two isoptres, I4e and I2e at two test speeds, 5/s and 3/s), reliability, and repeatability on Octopus 900. They noted that the reaction time decreased with age but blind spot area remained unchanged. Also, more reliable results were obtained when the stimulus velocity was 5/s.^[12] Rowe and Rowlands compared visual field assessment by Octopus 900 perimetry with Goldmann perimetry.^[5] Octopus perimetry reliably detected type and location of visual field loss, with the pattern of visual fields matched to Goldmann fields in 88.8% of eyes. In our study, 84% of field defects on GVF were detected by Octopus perimetry. Ninety-two percent of the eyes in our study showed at least a 3-quadrant agreement on Octopus visual field and GVF with V4e stimulus.

Rowe *et al.* compared semi-kinetic perimetry (SKP) on Octopus 900 perimetry to a peripheral static program with Humphrey automated perimetry. Eighty percent of results were correctly matched for normal or abnormal visual fields using the I4e target, and 73.5% were correctly matched using the I2e target.^[13] Another study by Rowe *et al.* studied 50 patients with pituitary disorders on HVF and Octopus 900 kinetic strategy. A match for normal/abnormal visual fields could

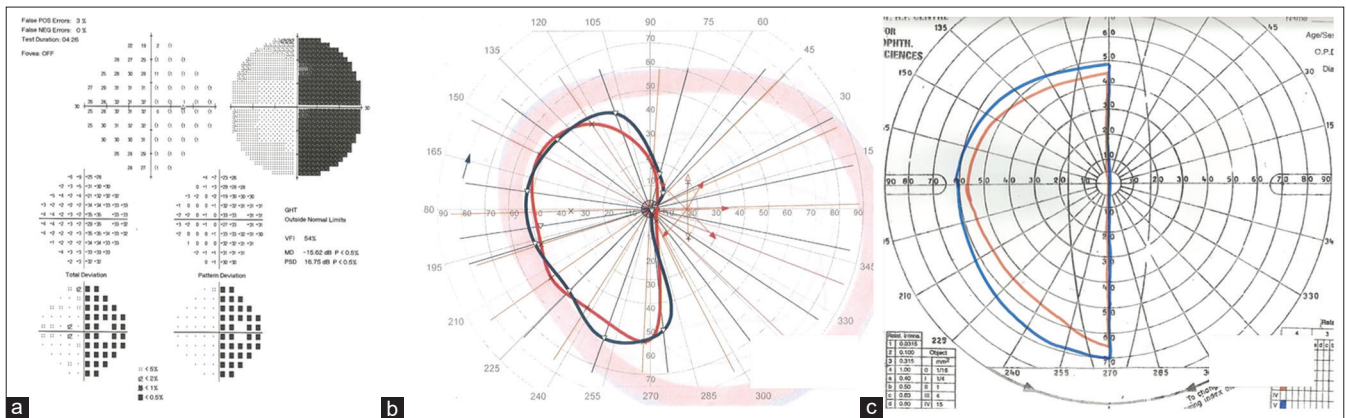


Figure 1: RE temporal field loss in Patient 5. Pattern of field defect is similar on HVF (a), Octopus (b) and GVF (c) perimeters respectively

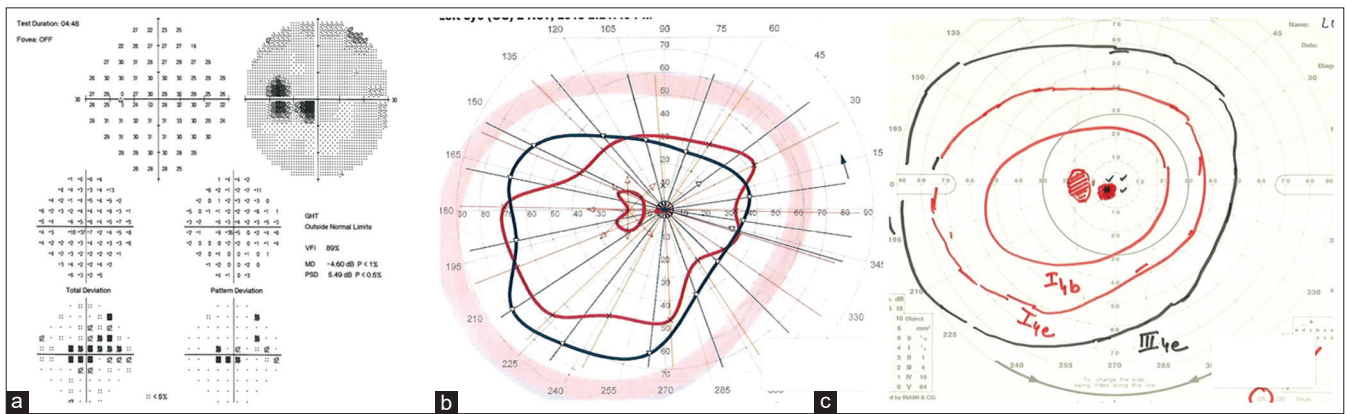


Figure 2: LE central scotoma with blind spot enlargement (Patient 10). Pattern of field defect matched on HVF (a) and GVF (c) but not on Octopus perimetry (b)

be obtained in 87% cases. HVF reported normal visual field in 2.6% of these patients but Octopus could detect peripheral superior defects in these. The authors stated that Octopus was twice as likely to give a clear representation of the actual visual field as HVF.^[14] We found that 84% of field defects on HVF were detected by Octopus perimetry. A match for normal/abnormal visual fields could be obtained in 88% cases, similar to the study by Rowe *et al.*^[14] The difference in duration taken to conduct visual field testing on HVF and Octopus was not statistically significant.

In our study, the agreement for visual field patterns between GVF and Octopus visual field and that between HVF and OVF was slightly higher for the unmasked observer (65% and 58% respectively) when compared with the masked observer (62% and 54% respectively), though not statistically significant. Thus, clinical correlation may help in better characterization of a field defect, although the same can also be a source for bias.

Correlation of the different patterns of visual fields with clinical diagnosis showed that all patients with central and paracentral scotomas showed unmatched fields when OVF was compared with HVF and GVF [Fig. 2]. This was attributed to the use of a default protocol in OVF where the test object was moved inward for assessment of central/centrocecal scotoma. This emphasizes the need for development of customized protocols (with target moving outward of the scotomata) for delineation of these field defects. Use of more stimulus sizes in

the Octopus test would make it more accurate, especially for complex visual field defects. However, it would also make the test duration lengthier.^[13] Goldmann allows manual tracking of eye movements as compared to Octopus and hence it may be better individualized for central defects than the latter. When patients with central/centrocecal field defects were excluded, sensitivity of Octopus increased to 95% (considering GVF as the gold standard). Other limitations of the study include a small sample size and lack of control group. Additionally, since repeat perimetry testing was not done in our study, reproducibility of the test could not be assessed. The possibility of stato-kinetic dissociation (a physiological phenomenon where static test overestimates the defect compared to kinetic test) should also be kept in mind when comparing the static Humphrey with the kinetic mode of Octopus.^[14,15]

Conclusion

The kinetic module of Octopus can be used for the evaluation of neuro-ophthalmic disorders when Goldmann perimeter is not available. Though all 3 perimeters were concurrent in the pattern of field defects for non-central defects, central and centrocecal field defects were missed on the default program in OVF. Developing a customized protocol with a target moving outward of the scotomata will improve their detection. Also, we observed that clinical correlation helps in better characterization of a field defect.

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The authors do not have any commercial interest in Octopus 900 Kinetic Perimeter (Haag Streit, Switzerland), Goldmann Perimeter (GVF) (Inami, Tokyo, Japan) or the Humphrey 750i Visual Field Analyzer (HVF) (Humphrey Instruments, Dublin, CA).

Conflicts of interest

There are no conflicts of interest.

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