Commentary: Evolving role of portable visual field testing in communities

Innovative technology is making it easier to assess visual function from home/community settings without need for huge infrastructural requirements of hospitals using portable or virtual methods. Such out-of-the clinic methods are likely to facilitate monitoring of patients with glaucoma or suspects and possibly screen for glaucoma detection particularly in low-resource communities. Portable visual field technologies have several advantages over conventional perimetric techniques. Though automated perimetry continues to be the gold standard in diagnosis and monitoring of persons with glaucoma, they are large and require stringent maintenance as to calibration and administered by trained perimetrist to ensure the subjects maintain focus and guided throughout the test. Perimetry test is highly subjective, prone for short- and long-term fluctuations in patient responses and needs to be repeated often to assess progression in those with established glaucoma. Added to these are problems with subject's focus, patient fatigue factors, and loss of attention resulting in inaccurate responses and interpretation. Typically, patients perform one to two tests in ophthalmology clinics per year, and fewer when lost to follow-up, even in developed health economies. Even in centers of excellence in glaucoma and tertiary eye care centers in India where recent generation of perimeters is widely available, it is impractical to perform perimetry on a routine basis to assess progression or periodically screen suspects given the logistics of cost of testing, crowded clinics, and increased wait times deterring periodical visual field testing.

Portable or virtual perimetry, which enables patients to test their visual function in home settings, avoiding travel and waiting time in the clinics, also decongests already resource-strained ophthalmology clinics, apart from being a major cost-saving measure. Home-based virtual perimetry is useful in reassuring that suspects have still not progressed from baseline requiring further observation and in assessing whether those with established glaucoma are progressing. Full-threshold visual field evaluation will still be required for confirmatory testing and any change in treatment recommendations. An easier, quicker, self-administered virtual testing could be used as an initial screening method to determine when patients need to visit an ophthalmologist for more definitive diagnostic evaluation. Most patients with glaucoma need to routinely visit an ophthalmologist every 3–6 months, depending on one's risk categorization and severity of disease. Virtual evaluation of visual function hence offers the possibility of remote monitoring and enabling tele-glaucoma care.

In one of the first reported home-based visual field test for glaucoma screening, Tsapaki *et al*.[1] used a software implementing a suprathreshold algorithm that allows self-testing using a computer monitor or virtual reality glasses on an Android smartphone with a 6-inch display. The software included an expert system to analyze the visual field images and validate the reliability of results. This home-based visual field test had exhibited a reasonable agreement with Humphrey visual field results without the need of specialized equipment, rendering the test useful for glaucoma screening. A recent study by Nakanishi *et al*.[2] describes validation of a portable brain–computer interface (nGoggle, NGoggle, Inc., San Diego, CA, USA) for objective assessment of visual function. The device integrates a wearable, wireless EEG system and a head-mounted display (HMD) to allow acquisition of multifocal steady-state visual-evoked potential signals (mfSSVEP) in response to visual stimulation. In a pilot study where nGoggle was compared with standard perimetry, assessment of diagnostic accuracy

was superior for the nGoggle parameters when compared with those of threshold perimetry. As a portable, objective method of assessing visual function, nGoggle appears to be a promising method in diagnosing or detecting progressive visual dysfunction in glaucoma, particularly when applied for home-based screening in underserved areas. In a yet another study validating a head-mounted virtual reality visual field screening device from India, Lukas and Swathi *et al*.[3] investigated the C3 field analyzer (CFA) as a possible subjective field test for glaucoma screening and monitoring. The CFA presented stimuli in the same positions as the Humphrey SITA 24-2 program using a suprathreshold algorithm. While the CFA could not reliably identify defects that matched standard threshold perimetry, it was moderately effective in identifying glaucoma subjects.

Johnson *et al*.[4] evaluated the performance of the Visual Field Easy (VFE) screening procedure in an iPad for clinic-based visual field testing and compared the results with conventional visual field evaluation by standard autoperimetry on Humphrey field analyzer. VFE is an application available for iPad that can be downloaded for free and evaluates 96 test locations (24 per visual field quadrant) throughout the central 30° of the visual field at a testing distance or 33 cm. A majority of patients were also subject to standard 24-2 SITA threshold perimetry. From their observations, the authors suggest that it is possible to perform visual function screening in remote communities using a tablet-based application. The sensitivity, specificity, and positive predictive value of such a screening procedure can be significantly enhanced when combined with other risk factors such as optic nerve appearance using portable non-mydriatic fundus photography, as well as clinical and demographic risk factors such as age, IOP, and family history of glaucoma when available. The investigators of the study found high correlation between conventional threshold automated perimetry and the table-based suprathreshold visual field test and this approach represents a paradigm shift for detecting potentially blinding conditions such as glaucoma in remote communities in a cost-effective manner. In a similar study in an Indian cohort,[5] comparing VFE with that of Humphrey SITA Fast strategy, investigators had comparable observations although it was not clear whether subjects had prior perimetric experience before being enrolled in the study. VFE, however, demonstrated the ability to accurately predict visual field dysfunction in patients with advanced glaucoma, though similar correlation could not be observed in persons with early to moderate glaucomatous visual field defects.

Although the authors of the current study do not recommend VFE for screening populations in communities owing to its poor accuracy in eyes with early glaucomatous visual loss, it can be expected that such inexpensive, suprathreshold testing strategies can be widely used by ophthalmologists to detect those with advanced glaucomatous disc damage in low-resource communities where screening populations is impractical. Incidentally, persons with such advanced disease are those at the highest risk of blindness in their lifetime and their detection and appropriate therapeutic intervention need to be prioritized. Needless to say, research needs to be focused on evolving more sensitive tools to screen for and identify individuals at risk of glaucoma blindness early in the course of the disease. Though further refinement is required, these portable visual testing applications hold promise for simplifying screening and will enable remote testing of populations with poor access to eye care or in their home settings to monitor glaucoma. It can thus be concluded that tablet-based visual field applications are a viable alternative for performing visual field screening for disease detection or monitoring in a variety of settings. In the not too remote future, such an approach is likely to provide visual function testing for not only glaucoma but also diabetic retinopathy and other ocular or neurologic diseases. Future research into refinement and validation of these approaches is likely to provide a means of screening large populations at risk, facilitating patients to perform not only home testing but also in vision centers and can be of immense value in tele-ophthalmology services, apart from waiting areas in busy ophthalmology clinics prior to consulting an ophthalmologist.

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