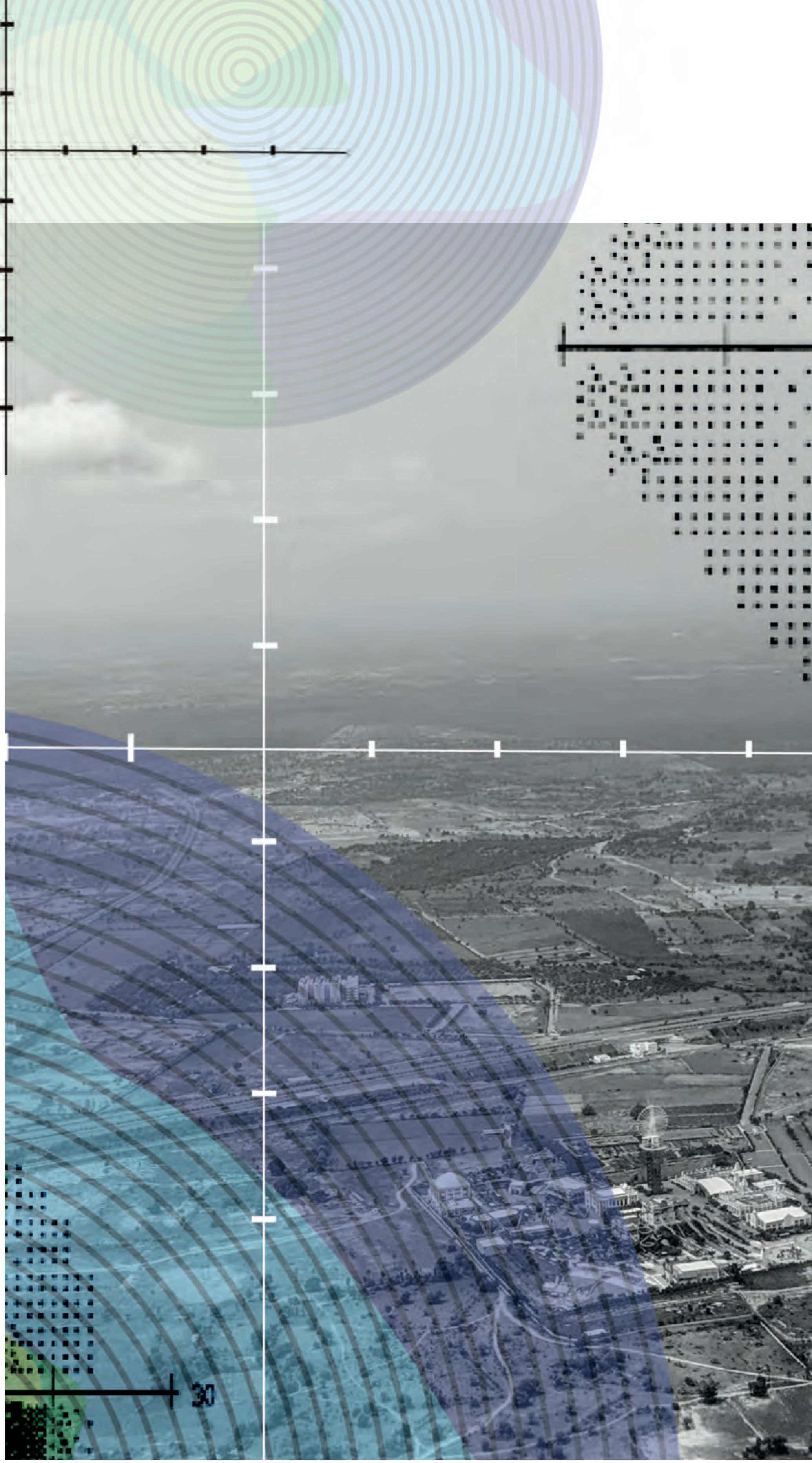
In the Field

How does a novel portable head-mounted perimeter compare with the gold standard in visual field testing?

By Reza Razeghinejad and Aakriti G. Shukla

Visual field testing is integral to the diagnosis and monitoring of patients with glaucoma and neuro-ophthalmic diseases. Perimetry has predominantly relied on automated devices that are large and cumbersome – and clearly not practical outside of the testing room. They also require the patient to maintain constant fixation for several minutes, which can be difficult or stressful for patients with learning difficulties, for the elderly, or for those who are simply nervous during the visual field test. Patients with musculoskeletal problems and those who have to maintain a horizontal position may have unreliable, artifact-laden results



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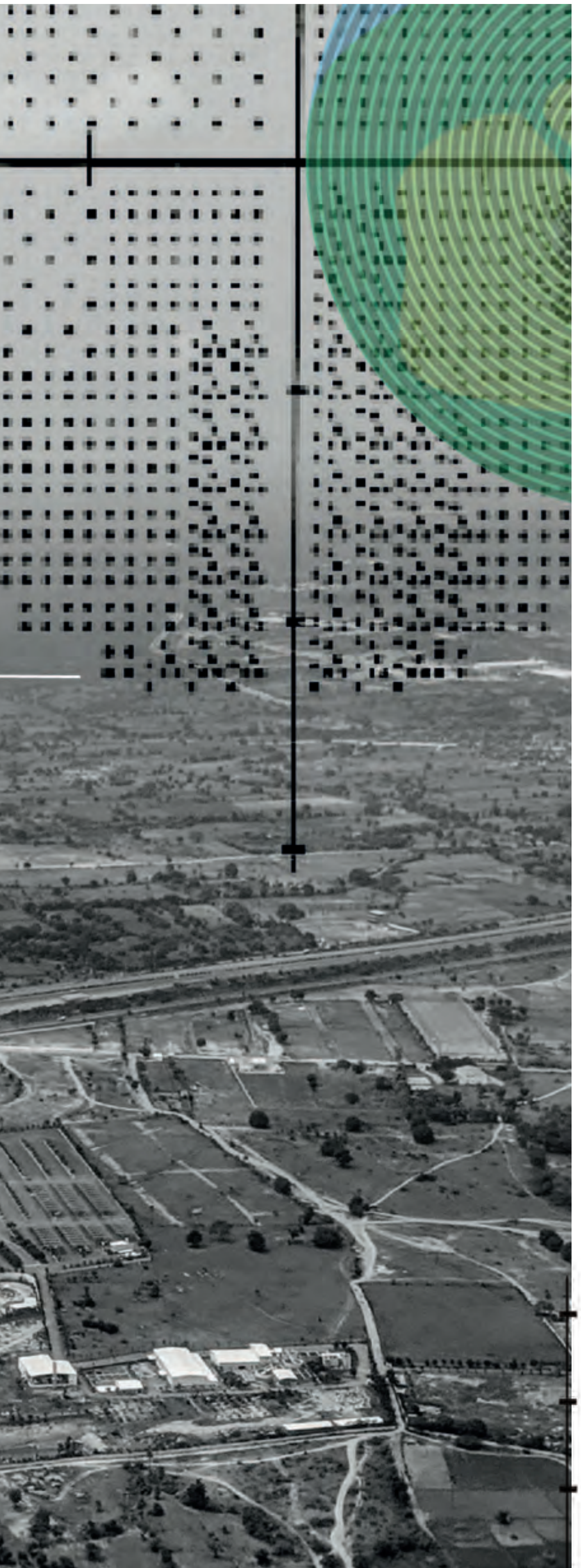

Pandemic perimetry

In the last few months, another important consideration for perimetry has come to our attention. Glaucoma services, like all other ophthalmic subspecialties, have been heavily affected by the COVID-19 pandemic. It is possible for the perimeter bowl to become contaminated in a traditional visual field-testing setting. Alcohol spray can be used to clean the interior of the perimeter bowl, but given the significant surface area of the bowl, this may be a time-consuming process. Head-mounted perimeters can be sanitized using alcohol and do not require the use of the bowl normally used for testing. Portable visual field tests have great potential in the delivery of good-quality vision care for glaucoma patients in situations where access to standard perimeters is difficult – in rural or remote locations, in developing countries, and under special circumstances, when patients are required to socially distance.

or may be unable to assume the correct position for the test.

Over the years, several devices have been introduced to make visual field testing easier for patients. And though these new modalities have brought much-needed portability, the lack of fixation, monitoring methods, and hardware standardization have limited their widespread use (1, 2). More recently, a new generation of head-mounted perimetry innovations have been developed and brought to market; their aim: to close the gap in visual field testing.

From theory to practice

At the Wills Eye Hospital Glaucoma Service, we recently conducted a study comparing a novel perimeter, the VisuALL Field Analyzer (from Olleyes Inc., Summit, New Jersey, USA). This head-mounted device (HMD) has eye tracking capabilities and its results have been found to be well-correlated with the well-known, widely-used Humphrey Field Analyzer (3, 4).

First, let us share some general information on the VisuALL perimeter: it is an FDA Class 1 device, and does not require the patient to use an eye patch or maintain a particular head position during the test. Its ergonomic design and minimal weight (0.3 kg) allow the patient to have unprecedented freedom of movement. Patients can wear their own glasses, eliminating the need for trial lenses. The device is composed of the HMD, a laptop, smartphone or tablet, and a Bluetooth-connected response button (see Figure 1). The HMD display is divided into two halves, one for each eye. Two tracking systems allow for an accuracy better than one degree.

So how does it work? The machine checks gaze position before presenting the stimulus, stops the test, and adjusts the location of stimulus properly if fixation is less than 15 degrees off center. If that is the case, the device presents a signal requesting that the patient returns to the central fixation target. The point pattern is similar to the -2 pattern in Humphrey Field Analyzer: a 6-degree grid pattern that straddles the horizontal and vertical midlines. VisuALL is technician independent as a demonstration video at the beginning of the test educates the patient on the simple testing process. The patient can take control over pausing and resuming the test. Once the test is finished, the results are saved into cloud storage.

Testing the test

Our study included 25 healthy subjects and 26 mild or moderate glaucoma patients. The diagnostic performance was assessed by means of receiver operating characteristic (ROC) curves, which provide a sensitivity/specificity trade-off (the value of the area under the ROC curve of 1 represents 100 percent accuracy). Bland-Altman plots were used to assess the discriminative ability of the device between healthy and glaucomatous eyes.

We found that the VisuALL testing time was approximately three minutes longer than on the Humphrey Field Analyzer for both healthy and glaucoma patients. The VisuALL uses full threshold strategy, which takes more time than SITA-standard. Retinal sensitivity measured by the VisuALL was similar to that of the Humphrey, and both were affected by the age of the individuals. The mean sensitivity of the whole visual field and all quadrants correlated significantly in both the healthy and glaucoma groups. The mean sensitivity of the VisuALL had a greater ROC than that of the Humphrey,

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although the difference was not statistically significant. The Bland-Altman plots also showed a good agreement between the mean sensitivity of the VisuALL and the HFA in both healthy and glaucoma patients.

The data from this pilot study are very encouraging: the VisuALL Field Analyzer was at least as good as, if not better than the Humphrey. The portability of the device allows it to be used in home-based settings, where many more tests could be done over time, potentially leading to earlier detection of glaucoma progression (5). We conducted another study to assess device performance in home-based perimetry – the results of which are being analyzed. Established glaucoma patients received the device by mail and checked their visual fields several times over one week. The results of the tests will be compared with the Humphrey data available in the patients' charts.

Adding pressure

Home tonometry is complementary to portable visual field testing. Our group continues to study home tonometry, which has demonstrated significant promise in providing accurate intraocular pressure measurement outside of office hours (6). Additionally, previous work has shown that mean IOP, maximum IOP, and IOP fluctuation can lead to significant changes in the visual field (7). What's more, disc hemorrhages lead to visual field loss that is more apparent in the central visual field, which may be more important for our patients' day-to-day activities, such as reading or driving (8). Linking home visual field testing with home tonometry allows for the close correlation of these two important data points outside of the glaucoma specialist's office.

Our work showed that the VisuALL perimeter successfully distinguished healthy subjects from glaucoma patients, and its results correlated well with the Humphrey Field Analyzer. We are already working on additional studies on patient preferences, repeat test performance, and clinical utility, as well as creating a normal visual field database.

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References

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