Journal Pre-proof

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PII: S1091-8531(23)00223-9

DOI: https://doi.org/10.1016/j.jaapos.2023.08.014

Reference: YMPA 3779

To appear in: *Journal of AAPOS*

Received Date: 22 May 2023

Revised Date: 22 August 2023

Accepted Date: 29 August 2023

Performance of virtual reality game–based automated perimetry in patients with childhood glaucoma

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Disclosures: SFF has a device on loan from Olleyes and Heidelberg Engineering. SA (research coordinator) is supported through funding from Lions Club Industries.

Presented at the 48th Annual Meeting of the American Association for Pediatric Ophthalmology and Strabismus, New York, New York, March 29-April 2, 2023.

Submitted May 22, 2023.
Revision accepted August 29, 2023.

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Word count: 2,227
Abstract only: 275

Abstract

Purpose

To evaluate VisuALL, a game-based automated perimetry device, utilizing virtual reality (VR) goggles, in a cohort of patients with childhood glaucoma.

Methods

In this prospective series, the results of consecutive patients with childhood glaucoma performing both VisuALL VR field (VRF) and Humphrey visual field (HVF) 24-2 testing were compared. A masked ophthalmologist graded both VRF and HVF tests for field defects (three clustered abnormal points in total or pattern deviation plot). VRF testing was performed binocularly and with the child's own spectacles. The two devices were assessed with respect to agreement of (1) global indices, such as mean deviation (MD) and pattern standard deviation (PSD), (2) point-by-point sensitivity, and (3) the ability to detect visual field defects determined by a grader.

Results

A total of 39 children (77 eyes) were enrolled, with mean age 14.1 ± 3.6 years; 3 patients (5 eyes) could not complete the HVF. Average HVF MD was −6.3 ± 6.4 dB. There was strong correlation between VRF and HVF for MD ($R = 0.68$, $P < 0.001$), PSD ($R = 0.78$, $P < 0.001$), and point-by-point sensitivity ($R = 0.63$, $P < 0.001$). Bland Altman analysis showed no systematic difference between VRF and HVF in assessing MD and PSD. Of 72 eyes having results for both modalities, 63 (87.5%) had agreement between VRF and HVF with respect to the presence/absence of any field defect, and 52 (72.2%) had agreement regarding the presence/absence of fixation-threatening field loss.

Conclusions

VRF is comparable to the gold standard HVF in both identification and quantification of visual field deficits in pediatric glaucoma patients and may offer a valuable supplement or alternative to standard automated perimetry.

Conventional standard automated perimetry (SAP) is a cornerstone in clinical management and decision making in glaucoma. However, conventional white-on-white perimetry, such as the Humphrey visual field (HVF; Zeiss HFA3, Oberkochen, Germany) or Octopus Perimetry (Haag Streit) can be challenging for many children to perform.[1] Advancement in virtual reality (VR) allows for new approaches for visual field testing, which in adults correlate well with SAP.[2,3] In addition, VR allows gamification of testing to potentially enlarge the age range over which visual field testing is possible and expands the possibility of home visual field monitoring.[2,4]

Despite the promise of VR-based visual field testing, relatively little information is available on its potential utility in children with glaucoma. VisuALL is a VR visual field assessment system that permits binocular testing of visual fields and allows gamification of the testing paradigm.[3] The purpose of the current study was to compare a game-based VR field (VRF) testing to conventional Humphrey visual field in a pediatric glaucoma population.

Participants and Methods

This prospective study protocol and consent form were approved by the Institution Review Board of Duke University Medical Center. Informed consent was obtained from the parents or guardians of all participants (age 6 years or older), with assent from children ≥12 years of age, and all research complied with the declaration of Helsinki.

All children (<21 years old) with known or suspected glaucoma at Duke University Medical Center under the care of one clinician (SFF) were enrolled prospectively from January 2022 to November 2022 and underwent a comprehensive eye examination, including intraocular pressure measurement, refraction, and stereo acuity testing. Patients were identified as having glaucoma based on the Childhood Glaucoma Research Network classification system with 2 or more of the following criteria: (1) intraocular pressure >21 mm Hg, (2) progressive myopia, (3) corneal enlargement or Haab striae, (4) characteristic optic nerve cupping or cup asymmetry and (5) reproducible field defects on prior visual field testing.[5] Glaucoma suspects were identified as having one (but not more) of the previous criteria.

All participants attempted conventional HVF 24-2 SITA Fast protocol (size 3 stimulus), followed by the game-based version of VisuALL VRF 24-2 (size 3 stimulus) with foveal sensitivity. The testing paradigm for VRF is provided in eSupplement 1 (available at jaapos.org). Foveal sensitivity, individual sensitivities at all points, global indices (*MD*, mean deviation; *PSD*, pattern standard deviation) were recorded and compared between the two devices.

Subjective interpretation by a trained ophthalmologist (BW) was performed for the presence of glaucomatous field defects, as defined by 3 clustered abnormal points depressed by at least 5 dB from normal age values[6] on one side of the horizontal meridian, and the location of the field defect (categorized by quadrants—superotemporal, superonasal, inferotemporal, inferonasal) was recorded for both VRF and conventional HVF.[7] Fixation-threatening field loss was defined as focal deficits in the central 4 points of fixation.[8] Both eyes of a single patient were presented to the masked ophthalmologist for grading; the HVF and VRF were independently graded by the same grader on different dates to avoid bias.

Statistical analysis was performed in R[9] (Mac version 4.0.2; https://www.r-project.org/) using linear-mixed effect modeling to account for the use of both eyes to assess the relationship between global indices (MD, PSD), foveal sensitivity, as well as individual point-by-point sensitivity between the two devices. Correlation values were computed using a linear model. Bland Altman plots were used to compare MD and PSD with 95% confidence internals. One proportion *Z* tests were used to evaluate for whether concordance of field defects were greater than due merely to chance.

Results

A total of 77 eyes of 38 patients were included. Average age was 14.1 ± 3.6 years. Three patients (2 7-year-olds and 1 15-year-old; 5 eyes) were able to complete the VRF but could not successfully complete the HVF 24-2. Average MD for HVF versus VRF was −6.3 ± 6.4 dB vs −5.2 ± 6.2 dB ($P = 0.743$). Average pattern standard deviation (PSD) for HVF versus VRF was 3.6 ± 3.0 dB vs 4.5 ± 2.6 dB ($P = 0.086$). Average test time per eye was 365 ± 108 sec for VRF and 238 ± 63 sec for HVF ($P < 0.001$). The remaining demographic information is summarized in Table 1.

There was strong correlation between VRF and HVF for MD ($R = 0.68$, $P < 0.001$; Figure 1A), and for PSD ($R = 0.78$, $P < 0.001$; Figure 1B). There was moderate correlation for point-by-point sensitivity ($R = 0.63$, $P < 0.001$; data not shown) and for foveal sensitivity ($R = 0.59$, $P < 0.001$; data not shown). Bland Altman analysis (eSupplement 2, available at jaapos.org) demonstrates a trend toward increasing variability of global parameters (MD and PSD), with worse disease process as assessed by worsening MD (more negative) and worsening PSD (more positive), but no systematic differences. There was no statistically significant difference in MD ($P = 0.060$) or PSD ($P = 0.448$) when comparing the two devices with age (eSupplement 3, available at jaapos.org).

Of 72 eyes with both HVF and VRF tests, 63 (87.5%, $P < 0.001$) had agreement between the two devices concerning the presence/absence of any field defect (examples shown in Figure 2) and 52 eyes (72.2%, $P < 0.001$) had agreement regarding the presence/absence of central (fixation-threatening) field loss. By quadrant, there was agreement regarding the presence/absence of field defects ranging from a low of 69.4% ($P = 0.001$) to a high of 83.3% ($P < 0.001$) for the superotemporal and inferonasal quadrants, respectively (eSupplement 4, available at jaapos.org). Analysis of patients with agreement and disagreement between VRF and HVF (eSupplement 5, available at jaapos.org) demonstrated discordant eyes tended to have milder disease as assessed by HVF MD −1.56 ± 1.97 dB, compared to −8.00 ± 8.02 dB (P = 0.037) for the eyes with concordance in their visual field findings.

Additional breakdown of eyes with discordant field findings demonstrated that there was no large bias toward one device identifying more abnormal fields than the other (eSupplement 6, available at jaapos.org). In patients with an OCT RNFL <70 μm (n = 25), VRF identified field defects in 100% (25 out of 25) of eyes, and HVF were abnormal in 92% (23/25) of these fields. Of the 2 eyes with field defects present in VRF but not HVF testing, 1 completed HVF testing with poor reliability and the other could not finish the HVF (Figure 3).

Discussion

This study demonstrates the performance of VisuALL, a game-based VRF, in a pediatric glaucoma and glaucoma suspect population. To our knowledge, this is the first study to utilize VRF in these children (see literature search below). Our findings add evidence to a growing body of literature in adults about the potential for VR and portable laptop fields to be transformative in office[3] as well as home testing.[2,4,10] In this study, we demonstrate that the VisuALL VRF is comparable to conventional HVF SAP and well tolerated in the pediatric glaucoma population.

The degree of correlation between the global indices for VRF and HVF is comparable to the only study in adults on non-game-based VRF by Razeghinejad and colleagues.[3] This group had found correlation of R = 0.5 and R = 0.8 for MD in healthy and glaucoma patients, respectively, when comparing HVF to VRF. Our slightly lower correlation (R = 0.68 for MD; R = 0.78 for PSD) is expected given that children typically perform worse on field testing compared to adults.[1] Other portable tests, such as those using the iPad[11] for field taking in adults, have demonstrated correlation as high as $R = 0.85$ for MD, but no pediatric studies are available for comparison. We found that variability between VRF and HVF tests increased with more severe glaucoma, which has been noted in published studies of adults.[12]

From a clinical decision-making perspective, VRF demonstrated excellent ability to identify the presence of both any field defect (eSupplement 5) or sectoral field defect (eSupplement 4). While we assumed that HVF was the gold standard for this study, there are indications that the VRF has performed as well as HVF. When we evaluated the subset of eyes with OCT RNFL <70 μm (n = 25), in whom we expected visual field defects, VRF identified defects in 100%, while HVF identified defects in only 92%. In the example shown in Figure 3, the severely thin RNFL in left eye indicates that VRF may have more accurately assessed the extent of field loss. When evaluating variation within the patient population regarding whether the VRF and HVF test were discordant, only milder disease severity as assessed by mean deviation was significantly associated with more discordant fields. Patients with advanced glaucoma will likely show a deficit on both VRF and HVF; however, patients with mild disease and early perimetric glaucoma may be missed by either one of the devices. This may also represent a ceiling effect for VRF for detecting very mild disease, which may be a limitation of the platform.[6]

The longer duration of testing for the game-based VRF was expected, because the child was required not only to identify the presence of a stimulus, but also to move the fixation point to the stimulus to receive “credit” for having seen the specific target. Despite the longer duration, participants in this study preferred the VRF over conventional HVF. There is potential to improve the testing speed with algorithm changes, which merits further exploration. Other types of VR field testing, such as the Vivid Vision Perimetry[2] and iPad based testing,[11] have been reported in adults to be comparable to conventional perimetry but with a shorter test time.

VRF testing offers the advantage of not requiring a dedicated testing area or examination room, and it may be more comfortable for certain patient populations. There is a large body of literature on adults for home-based visual field testing[13-16] to provide potential earlier identification of disease progression. Future studies are warranted to evaluate VRF for home use in the pediatric population.

It is encouraging to find good correlation in fields taken with HVF and VRF, but there are limitations to this study that must be acknowledged. This study was undertaken with the underlying assumption that conventional HVF is the gold standard, with this modality often being the patients' first visual field test. Given the expected learning effect of visual field testing, there is a high likelihood that our gold standard is still suboptimal. Further studies are required on the learning effect (including test-retest reliability) of field tests in this age group to fully elucidate the results of the field tests in children with known and suspected glaucoma. In addition, while the patients preferred the game-based VRF compared to conventional HVF, further studies are necessary in children to identify whether a game-based VRF is clinically superior to a non-game-based VRF. The non-game-based VRF, which is similar to the HVF 24-2 algorithm, is also available on the VisuALL system and has been found to be comparable to HVF in adults.[3] All patients took the VRF after attempted or successful HVF standard automated perimetry to minimize the child's fatigue prior to taking the clinically indicated HVF. However, it is possible that this sequence led to a learning effect for the VRF. It is also important to recognize that a small portion of these patients had taken HVF tests in previous examination sessions, which is expected to produce a learning effect perhaps favoring the accuracy of the HVF over the VRF in these children.[17]

Due to the interactive nature of the game-based VRF, false positives could not be recorded, and false negatives were not comparable to the conventional HVF. Care must be taken when using these values to assess the extent of field quality for the game-based VRF.

In conclusion, VRF offered good correspondence in global parameters and point-by-point sensitivity compared to HVF in a cohort of pediatric patients with known or suspected glaucoma. VRF was able to identify the presence of field defects at a level comparable to HVF and was well tolerated in the patient cohort. VRF testing may provide a suitable substitute for clinical practices without easy access to a HVF device and has potential for future studies.

Literature Search

PubMed was searched in October of 2023 for English-language results using the following terms: *visuall* OR *virtual reality field* AND *glaucoma*. A total of 53 publications were retrieved, none including children with glaucoma.

References

1. Heidary G. Visual field testing in pediatric patients. J Pediatr Neurol 2017;15:10-14.
2. Greenfield JA, Deiner M, Nguyen A, et al. Virtual reality oculokinetic perimetry test reproducibility and relationship to conventional perimetry and OCT. Ophthalmol Sci 2022;2:100105.
3. Razeghinejad R, Gonzalez-Garcia A, Myers JS, Katz LJ. Preliminary report on a novel virtual reality perimeter compared with standard automated perimetry. J Glaucoma 2021;30:17-23.
4. Hu GY, Prasad J, Chen DK, Alcantara-Castillo JC, Patel VN, Al-Aswad LA. Home monitoring of glaucoma using a home tonometer and a novel virtual reality visual field device: acceptability and feasibility. Ophthalmol Glaucoma 2023;6:121-8.
5. Thau A, Lloyd M, Freedman S, Beck A, Grajewski A, Levin AV. New classification system for pediatric glaucoma: implications for clinical care and a research registry. Curr Opin Ophthalmol 2018;29:385-94.
6. Groth SL, Linton EF, Brown EN, Makadia F, Donahue SP. Evaluation of virtual reality perimetry and standard automated perimetry in normal children. Transl Vis Sci Technol 2023;12:6.
7. Comparison of glaucomatous progression between untreated patients with normal-tension glaucoma and patients with therapeutically reduced intraocular pressures. Am J Ophthalmol 1998;126:487-97.
8. Membrey WL, Poinoosawmy DP, Bunce C, Fitzke FW, Hitchings RA. Comparison of visual field progression in patients with normal pressure glaucoma between eyes with and without visual field loss that threatens fixation. Br J Ophthalmol 2000;84:1154-8.

9. Team RDC. R: a language and environment for statistical computing. R Found Stat Comput. Published online 2008.

10. Jones PR, Campbell P, Callaghan T, et al. Glaucoma home monitoring using a tablet-based visual field test (Eyecatcher): an assessment of accuracy and adherence over 6 months. Am J Ophthalmol 2021;223:42-52.

11. Prea SM, Kong GYX, Guymer RH, Vingrys AJ. Uptake, Persistence, and performance of weekly home monitoring of visual field in a large cohort of patients with glaucoma. Am J Ophthalmol 2021;223:286-95.

12. Yohannan J, Wang J, Brown J, et al. Evidence-based criteria for assessment of visual field reliability. Ophthalmology. 2017;124:1612-20.

13. Anderson AJ, Bedggood PA, George Kong YX, Martin KR, Vingrys AJ. Can home monitoring allow earlier detection of rapid visual field progression in glaucoma? Ophthalmology 2017;124:1735-42.

14. Aboobakar IF, Friedman DS. Home monitoring for glaucoma: current applications and future directions. Semin Ophthalmol 2021;36:310-14.

15. Tsapakis S, Papaconstantinou D, Diagourtas A, et al. Home-based visual field test for glaucoma screening comparison with Humphrey perimeter. Clin Ophthalmol Auckl NZ 2018;12:2597-2606.

16. Jones L, Callaghan T, Campbell P, et al. Acceptability of a home-based visual field test (Eyecatcher) for glaucoma home monitoring: a qualitative study of patients' views and experiences. BMJ Open 2021;11:e043130.

17. Wood JM, Wild JM, Hussey MK, Crews SJ. Serial examination of the normal visual field using Octopus automated projection perimetry: evidence for a learning effect. Acta

Ophthalmol (Copenh) 1987;65:326-33.

Legends

FIG 1. Scatterplot demonstrating the relationship in (A) mean deviation (MD) and (B) pattern standard deviation (PSD) between Humphrey visual fields (HVF) and virtual reality fields (VRF). The black line indicates best-fit linear regression; the red line, line of optimal fit if HVF and VR global indices were exactly equal.

FIG 2. Example of visual fields (by grayscale and pattern standard deviation) with concordant fields for a (A) 10-year-old and (B) 16-year-old patient with pediatric glaucoma. *HVF*, Humphrey visual field; *VRF*, virtual reality field.

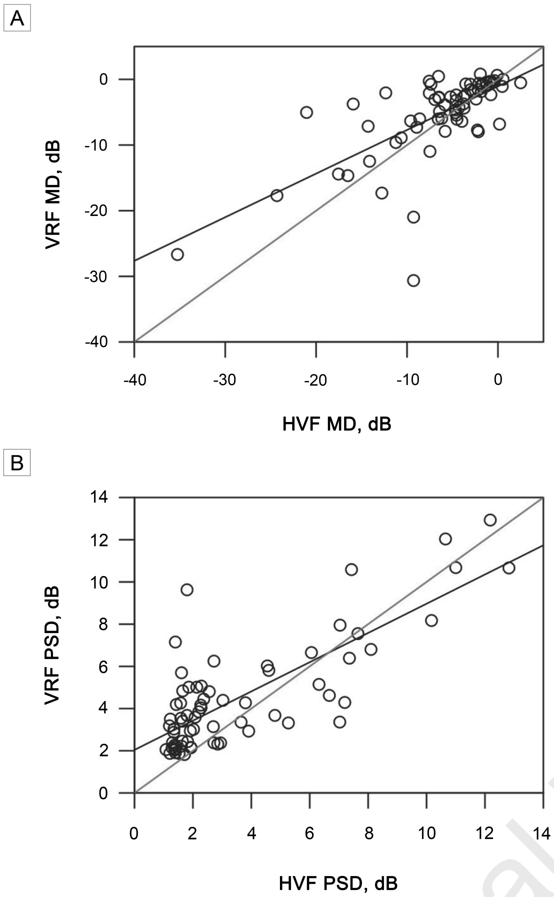
FIG 3. Example of visual fields and optical coherence tomography (OCT) for left eye of a 17-year-old with severe glaucoma. A, HVF (0/11 fixation losses, 0% false positive, 6% false negative) with grayscale and pattern deviation shows moderate glaucoma damage. B, VRF demonstrates much more significant losses on grayscale and pattern deviation. C, OCT retinal nerve fiber layer thickness map (demonstrating severe thinning in the left eye eye) with segmentation results.

Table 1. Patient demographics and characteristics

Characteristic	Glaucoma (n = 38, 77 eyes)[a]
Age, years	14.1 ± 3.6
Eye (right/left)	33/35
Visual acuity, logMAR	0.37 ± 0.45
OCT	
Average RNFL, μm	83.0 ± 26.5
HVF	
Average mean deviation, dB	−6.3 ± 6.4
Average pattern deviation, dB	3.6 ± 3.0
Average foveal sensitivity, dB	32.7 ± 6.9
Test duration, sec	238 ± 63
VRF	
Average mean deviation, dB	−5.2 ± 6.2
Average pattern deviation, dB	4.5 ± 2.6
Average foveal sensitivity, dB	29.1 ± 9.2
Test duration, sec	365 ± 108
Diagnosis, no. (%)	
Primary congenital glaucoma	22 (28.6)
Glaucoma following cataract surgery	15 (19.4)
Glaucoma secondary to nonacquired conditions (eg, anterior segment dysgenesis)	10 (13.0)
Glaucoma secondary to acquired conditions (eg, uveitis, trauma)	11 (14.3)
Juvenile open-angle glaucoma	8 (10.4)
Glaucoma suspect	11 (14.3)

HVF, Humphrey visual field; *OCT*, optical coherence tomography; *VRF*, VisuALL VR field.

[a]Values represent mean ± standard deviation unless otherwise stated.


A
VRF MD, dB
HVF MD, dB
0
-10
-20
-30
-40
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B
VRF PSD, dB
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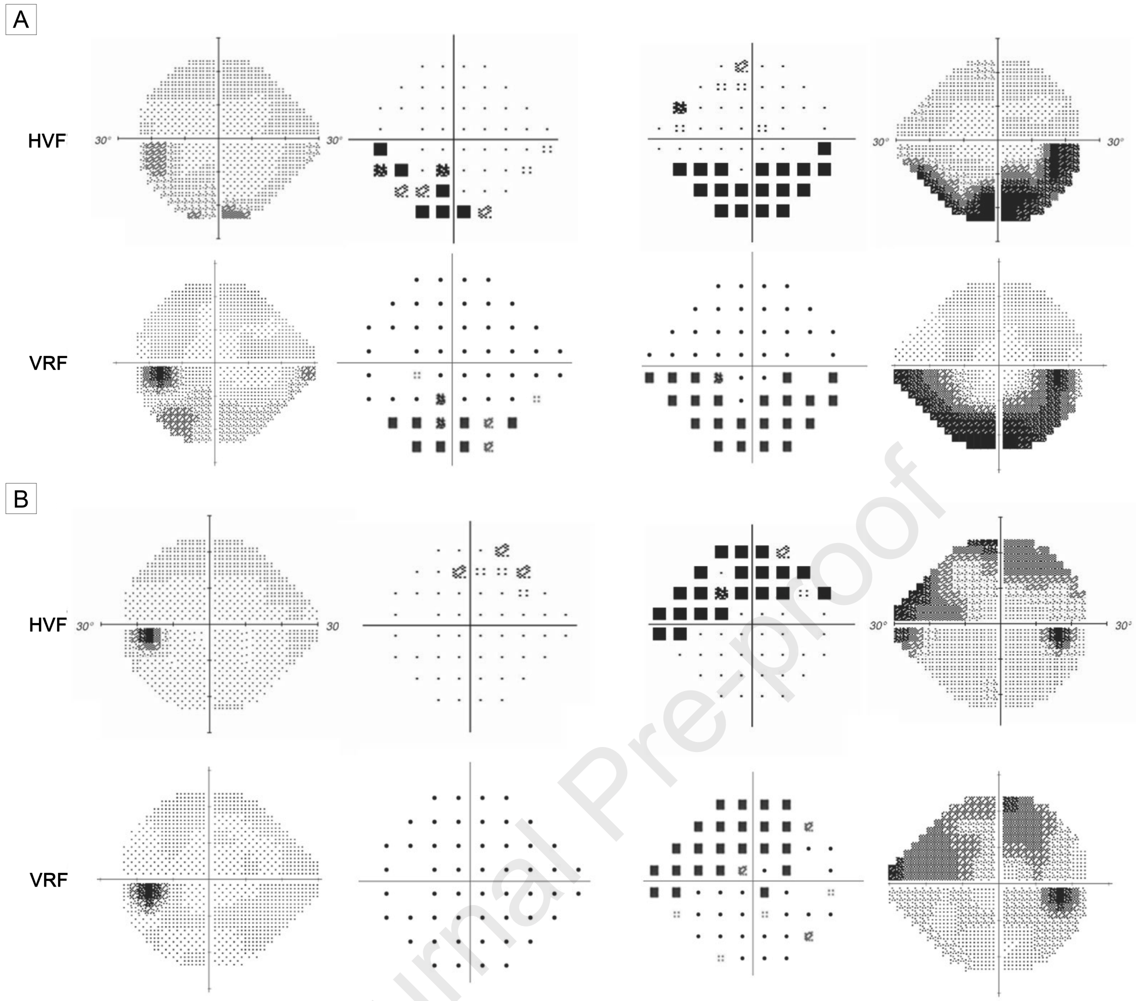

A
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B
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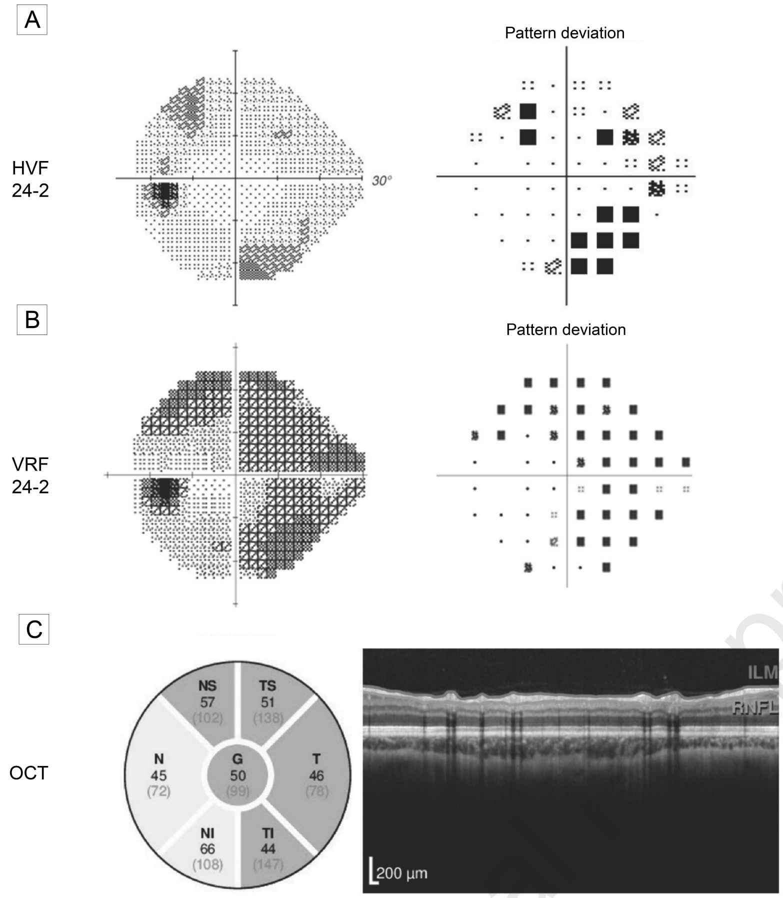
VRF


A
Pattern deviation
HVF
24-2
30°
B
Pattern deviation
VRF
24-2
C
OCT
NS
57
(102)
TS
51
(138)
N
45
(72)
G
50
(99)
T
46
(78)
NI
66
(108)
TI
44
(147)
ILM
RNFL
200 μm

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Abstract

Purpose

To evaluate VisuALL, a game-based automated perimetry device, utilizing virtual reality (VR) goggles, in a cohort of patients with childhood glaucoma.

Methods

In this prospective series, the results of consecutive patients with childhood glaucoma performing both VisuALL VR field (VRF) and Humphrey visual field (HVF) 24-2 testing were compared. A masked ophthalmologist graded both VRF and HVF tests for field defects (three clustered abnormal points in total or pattern deviation plot). VRF testing was performed binocularly and with the child's own spectacles. The two devices were assessed with respect to agreement of (1) global indices, such as mean deviation (MD) and pattern standard deviation (PSD), (2) point-by-point sensitivity, and (3) the ability to detect visual field defects determined by a grader.

Results

A total of 39 children (77 eyes) were enrolled, with mean age 14.1 ± 3.6 years; 3 patients (5 eyes) could not complete the HVF. Average HVF MD was −6.3 ± 6.4 dB. There was strong correlation between VRF and HVF for MD (R = 0.68, P < 0.001), PSD (R = 0.78, P < 0.001), and point-by-point sensitivity (R = 0.63, P < 0.001). Bland Altman analysis showed no systematic difference between VRF and HVF in assessing MD and PSD. Of 72 eyes having results for both modalities, 63 (87.5%) had agreement between VRF and HVF with respect to the presence/absence of any field defect, and 52 (72.2%) had agreement regarding the presence/absence of fixation-threatening field loss.

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The study was a prospective series of childhood glaucoma patients at a single institution performing both VisuALL VR field (VRF) and Humphrey visual field (HVF) 24-2 testing. Patients were identified as having glaucoma based on the Childhood Glaucoma Research Network classification system.[5] VRF testing was performed binocularly and with the child's own spectacles. A masked ophthalmologist graded both VRF and HVF tests for field defects (3 clustered abnormal points in total or pattern deviation plot). The agreement of (1) global indices, such as mean deviation (MD) and pattern standard deviation (PSD), (2) point-by-point sensitivity, and (3) the ability to detect visual field defects determined by a grader was assessed between the two devices.

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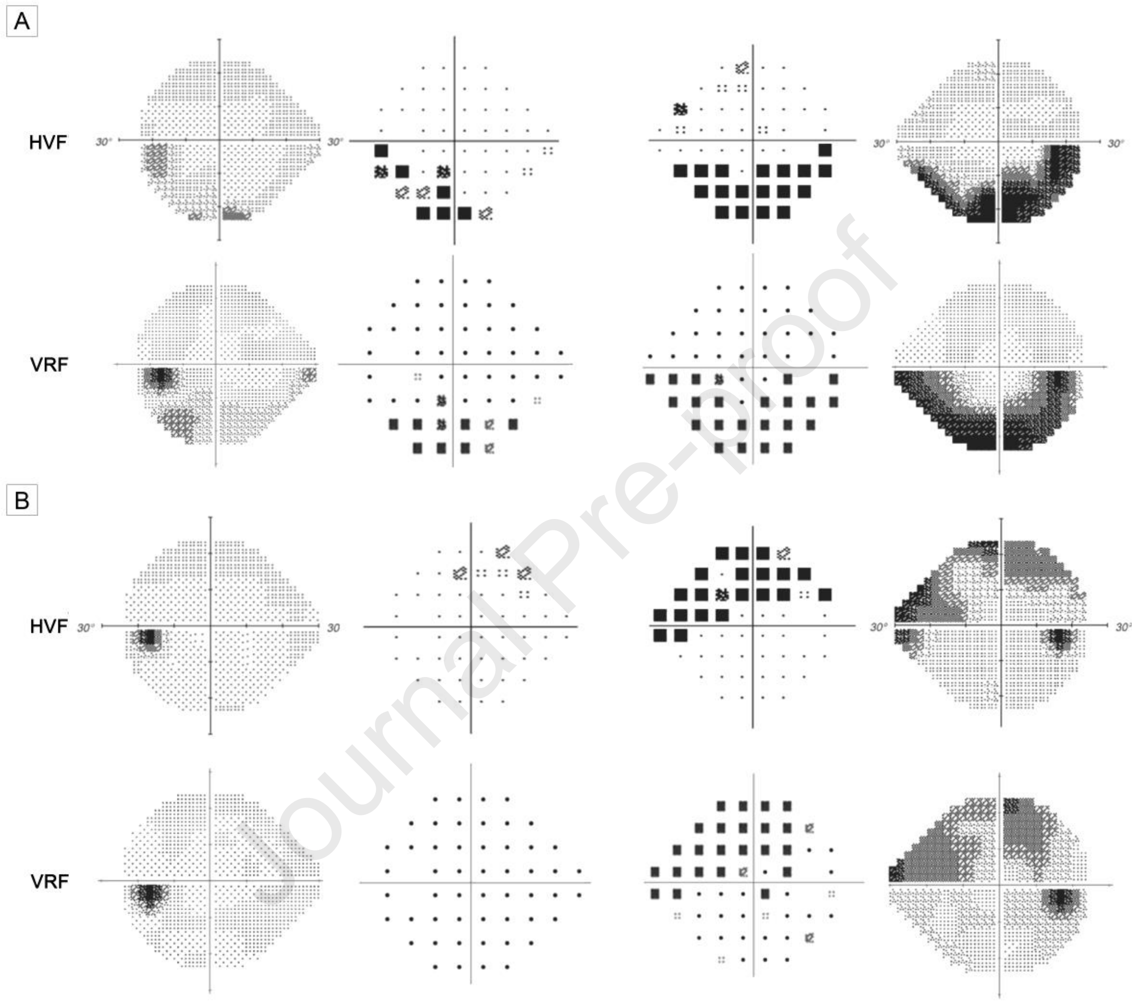

References

1. Heidary G. Visual field testing in pediatric patients. J Pediatr Neurol 2017;15:10-14.
2. Greenfield JA, Deiner M, Nguyen A, et al. Virtual reality oculokinetic perimetry test reproducibility and relationship to conventional perimetry and OCT. Ophthalmol Sci 2022;2:100105.
3. Razeghinejad R, Gonzalez-Garcia A, Myers JS, Katz LJ. Preliminary report on a novel virtual reality perimeter compared with standard automated perimetry. J Glaucoma 2021;30:17-23.
4. Hu GY, Prasad J, Chen DK, Alcantara-Castillo JC, Patel VN, Al-Aswad LA. Home monitoring of glaucoma using a home tonometer and a novel virtual reality visual field device: acceptability and feasibility. Ophthalmol Glaucoma 2023;6:121-8.
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6. Jones PR, Campbell P, Callaghan T, et al. Glaucoma home monitoring using a tablet-based visual field test (Eyecatcher): an assessment of accuracy and adherence over 6 months. Am J Ophthalmol 2021;223:42-52.