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Original Article

Evaluation of the Deep Reality Viewer for teaching slit-lamp examination of the anterior segment and the optic nerve head

Edward Tran,* Eknoor Padda,† Rahul A. Sharma,*,‡ Iqbal Ike K. Ahmed*,‡,§

Objective: A major challenge in teaching slit-lamp biomicroscopy is providing adequate depth perception and anatomical detail; the Deep Reality Viewer (DRV) addresses this by enabling stereopsis. This study evaluated the utility of DRV for slit-lamp examination (SLE) teaching and compared it with 2-dimensional monitors.

Methods: In this single-centre prospective comparative study, 33 medical learners completed a qualitative assessment comparing DRV versus 2-dimensional (2D) monitors for SLE of the anterior segment and optic nerve head (ONH). Perceived educational value and task-specific utility were compared across 16 Likert-scale (1−5) parameters in 4 domains: image quality, anatomical visualization, user experience, and teaching utility. The primary outcome was the comparison of teaching utility ratings between modalities. Secondary outcomes included composite domain scores, trainee-level differences, and intermodality agreement for ONH assessments.

Results: Median [IQR] DRV was rated significantly higher than 2D monitors for image quality (4.3 [4.0−4.6] vs 3.5 [3.3−4.2]; $p < .001$), anatomical visualization (4.4 [4.0−4.8] vs 3.6 [3.2−4.3]; $p < .001$), and teaching utility (5.0 [4.5−5.0] vs 4.0 [3.8−4.8]; $p < .001$). Cup-to-disc ratio estimates showed minimal systematic bias (mean differences −0.01 to 0.03) with no significant difference in variability between DRV and 2D monitors (all $p > .05$). Subjective ratings of ONH visual quality did not significantly differ between modalities (all $p > .05$).

Conclusions: DRV may be a useful tool to improve SLE teaching, as its perceived image quality and depth perception appear superior to 2D monitors.

Average ophthalmology teaching time for medical trainees has decreased from 92.9 to 52.9 hours in the past 2 decades, creating an urgent need to optimize teaching to preserve trainees' skills and confidence.[1] Slit-lamp biomicroscopy is a fundamental component of the ocular examination.

Common teaching aids, such as traditional teaching microscopes and 2-dimensional (2D) monitors, lack stereopsis or binocular 3-dimensional (3D) vision.[2,3] Without stereopsis, trainees can have difficulty visualizing depth-sensitive ocular anatomy and pathology.[3] Binocular vision is particularly important for accurate examination of the optic nerve, where stereopsis helps assess disc contour, colour, size, and cup-to-disc ratio.[1] These features provide key information for identifying papilledema and optic neuropathies, such as glaucoma and optic disc drusen.[2] Many medical learners lack confidence in identifying key optic nerve findings, a problem compounded by the declining use of direct ophthalmoscopy among non-ophthalmologists.[3] Despite its importance, fundoscopic assessment remains a technically challenging and often under-taught skill, leading to poor identification of optic nerve features and necessitating alternative teaching and assessment methods.[4]

Despite the known advantages of 3D systems in microsurgery,[5] evidence of their value in slit lamp examinations is limited. Studies comparing real-time digital camera displays to traditional teaching microscopes have shown that, while 2D systems facilitate simultaneous teaching to multiple observers, they do not convey the depth perception that trainees need to accurately assess ocular anatomy and ophthalmic pathology.[6,7]

The Deep Reality Viewer (DRV; Vision Engineering, Woking, UK; single-view design) is a novel, heads-up, glasses-free display that preserves true binocular 3D vision, thereby overcoming this limitation. The system uses optical and digital technologies to create 2 independent optical paths, each presenting the subject from slightly different angles to provide stereoscopic vision without specialized glasses.[8] Evidence for the DRV in ophthalmology education is limited; to date, only 1 pilot microsurgical simulation study, covering corneal suturing and incision creation, has been reported.[9] This study evaluates the DRV system's perceived educational value and task-specific utility in teaching slit-lamp examination of the anterior segment and optic nerve head (ONH) versus traditional 2D monitors.

Methods

Study design and setting

We carried out this prospective, comparative study at a single centre, comparing the DRV with a standard 2D monitor for teaching slit-lamp examination techniques. The DRV was attached directly to the slit lamp (Fig. 1). Visual

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Fig. 1—Set-up of the Deep Reality Viewer (left) connected directly to the slit lamp biomicroscope (right).

input from one eyepiece's optical channel was connected to a monitor. Data were collected between July and October 2025. As part of routine medical education, this quality-improvement initiative was considered to be program evaluation under the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2 (Article 2.5) and, therefore, formal ethics approval was not required.

Study participants

Medical students, ophthalmology residents and clinical fellows, and observers with normal or corrected-to-normal vision participated in the clinic's training activities after providing implied consent. We defined observers as nonenrolled learners, including ophthalmology graduates seeking additional exposure, international medical graduates, university students, and non-physician health care professionals. Trainees with prior use of DRV, ocular pathology, or impairments affecting binocular vision were excluded.

Study procedures

Participant demographics, including age, sex, and trainee level, were collected before participation. Participants completed one or both assessments: a real-time anterior segment examination and an ONH assessment using standardized images. The sequence of the viewing modality, either the DRV or 2D monitor, was randomized to limit order and learning effects.

In the anterior segment examination, participants observed live slit-lamp examinations with each viewing modality, covering lids and lashes, conjunctiva and sclera, cornea, anterior chamber, iris, and lens. After each examination, they completed a 5-point Likert-scale questionnaire assessing different parameters for each viewing modality (see Supplementary Fig. 1A online).

In the ONH assessment, participants viewed 4 standardized posterior-segment images of the ONH with each modality and completed a structured evaluation comprising cup-to-disc ratio, disc margin clarity, disc colour, presence of peripapillary atrophy (PPA), and disc tilt (see Supplementary Fig. 2 online). After each examination, they completed another 5-point Likert-scale questionnaire assessing different parameters in the context of the ONH evaluation (see Supplementary Fig. 1B online).

Outcome measures

The primary outcome was the DRV's suitability for teaching slit-lamp examination and compared it with 2D

monitors. This was evaluated with a composite domain score, teaching utility, combining 2 parameters: ease of receiving instructor guidance and suitability for SLE teaching.

Secondary outcomes included composite domain scores for image quality, anatomical visualization, and user experience. Image quality comprised resolution, colour fidelity, brightness, contrast for key findings, depth perception, and field of view. Anatomical visualization comprised clarity of the eyelid margin and eyelashes, the conjunctiva and sclera, and the corneal layers, as well as visualization of anterior chamber structures and visibility of the iris architecture and pupillary border. User experience comprised ergonomic and visual comfort, confidence in identifying anatomical structures, and overall satisfaction. Subgroup comparisons across training levels were also assessed.

For the optic nerve head assessments, we evaluated interuser variability by comparing agreement among medical learners for each optic nerve feature (vertical cup-to-disc ratio, disc margin clarity, disc colour, peripapillary atrophy, disc tilt). Interuser variability was summarized and compared between the DRV and the 2D monitor. Task-specific validity for ONH was assessed across 4 parameters, disc margin visibility, disc colour accuracy, disc size clarity, and clarity of cup-to-disc ratio estimation, with each rated on a 5-point Likert scale and compared between the 2 viewing modalities. Then, a board-certified glaucoma specialist reviewed all optic nerve head images and provided reference standard assessments for each feature (vertical cup-to-disc ratio, peripapillary atrophy, disc tilt). We used these assessments to calculate diagnostic accuracy metrics: each response was classified as true positive, false positive, true negative, or false negative, based on agreement with the specialist's evaluation. We calculated sensitivity, specificity, and overall accuracy for each optic nerve feature and compared these metrics between the DRV and 2D monitor.

Statistical analysis

Data were analyzed using R software (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at $p \leq .05$. Data normality was first assessed using the Shapiro–Wilk test. The Wilcoxon test was used for non-normal distributions, presented as medians and interquartile range (IQR), and the Student's t test was used for normal distributions, presented as means and 95% CI.

For the anterior segment examinations, the composite domain score comparison was conducted using matched-pair analyses. The study has 99.7% power to identify a significant effect size (Cohen's $d = 0.99$) for the primary outcome.

For the optic nerve head assessments, within-subject agreement for continuous features (i.e., vertical cup-to-disc ratio) between the DRV and the 2D monitor was evaluated using Bland–Altman analysis, and homogeneity of variance was assessed with Levene's test. For categorical features (i.e., disc margin clarity, disc colour, peripapillary atrophy, and disc tilt), within-subject agreement between modalities was evaluated using weighted Cohen's κ, and systematic bias in paired ratings was assessed with Bowker's test of symmetry.

Post hoc pairwise comparisons using Wilcoxon signed-rank tests examined ratings stratified by training level to investigate whether learner level (medical student, resident, or fellow) affected the modality effect. To minimize potential bias related to prior familiarity or knowledge, observer identity was not included in these analyses. These analyses were exploratory in nature due to the small sample size in certain training groups.

Results

Participant characteristics

Thirty-three participants completed evaluations of the DRV and the 2D monitor for observing anterior segment examinations using slit lamp biomicroscopy. Twenty participants completed ONH assessments using slit-lamp photographs viewed on either the DRV or a 2D monitor. Participants were 51.5% female, and the median age was 23.0 years (IQR: 21.5–27.0 years). Most participants were medical students (51.5%) and clinical fellows (21.2%).

Primary outcome: teaching utility

All primary teaching utility outcomes are summarized in Table 1. Teaching utility scores were higher with the DRV than with the 2D monitor (median 5.0 [IQR 4.5–5.0] vs 4.0 [3.8–4.8]; $p < .0001$). Both suitability for slit-lamp examination teaching and ease of receiving instructor guidance were higher with the DRV than with the 2D monitor: 5.0 [IQR 4.0–5.0] vs 4.0 [3.0–5.0]; $p = .0009$ and 5.0 [4.0–5.0] vs 4.0 [4.0–5.0]; $p = .017$, respectively.

Secondary outcomes: anterior segment examination

All secondary outcome measures are summarized in Table 1. Image quality was rated higher with the DRV than with the 2D monitor (4.3 [4.0–4.6] vs 3.5 [3.3–4.2]; $p < .0001$). Depth perception showed the largest difference (4.0 [4.0–5.0] vs 3.0 [2.5–3.5]; $p < .0001$). Anatomical visualization was rated significantly higher with the DRV than with the 2D monitor, across all parameters ($p = .0002$). User experience did not differ between the DRV and 2D monitor (4.5 [3.8–5.0] vs 4.0 [3.8–4.5]; $p = .30$). Although, overall satisfaction (4.0 [4.0–5.0] vs 4.0 [3.0–4.0]; $p = .0089$) was rated higher with the DRV. Post hoc pairwise comparisons across training levels revealed no significant differences for all parameters ($p > .05$).

Table 1—Comparison of image quality, anatomical visualization, user experience, and teaching utility for the Deep Reality Viewer compared to a 2-dimensional monitor

Parameter	DRV Median (IQR)	Monitor Median (IQR)	*P* value
Image quality	4.3 (4.0–4.6)	3.5 (3.3–4.2)	<.0001
Image quality/resolution	4.0 (4.0–5.0)	4.0 (3.0–5.0)	.06
Colour fidelity	4.0 (4.0–5.0)	4.0 (3.5–5.0)	.03
Brightness	4.0 (4.0–5.0)	4.0 (3.0–4.5)	.01
Contrast for key findings	4.0 (4.0–5.0)	4.0 (3.0–4.0)	.05
Depth perception	4.0 (4.0–5.0)	3.0 (2.5–3.5)	<.0001
Field of view	5.0 (4.0–5.0)	4.0 (3.0–5.0)	.008
Anatomical visualization	4.4 (4.0–4.8)	3.6 (3.2–4.3)	.0002
Clarity of eyelid margin and eyelashes	5.0 (4.0–5.0)	4.0 (3.5–5.0)	.0001
Clarity of conjunctiva and sclera	5.0 (4.0–5.0)	4.0 (4.0–5.0)	.0002
Clarity of corneal layers	4.0 (3.0–5.0)	3.0 (3.0–4.0)	.003
Visualization of anterior chamber structures	4.0 (3.5–5.0)	3.0 (2.5–4.0)	.001
Visibility of iris architecture and pupil border	5.0 (4.0–5.0)	4.0 (3.0–4.5)	<.0001
User experience score	4.5 (3.8–5.0)	4.0 (3.8–4.5)	.29
Ergonomic comfort	5.0 (3.5–5.0)	5.0 (4.0–5.0)	.48
Visual comfort	4.0 (4.0–5.0)	5.0 (4.0–5.0)	.50
Confidence in identifying anatomical structures	4.0 (4.0–5.0)	4.0 (3.0–4.0)	.003
Satisfaction	4.0 (4.0–5.0)	4.0 (3.0–4.0)	.009
Teaching utility score	5.0 (4.5–5.0)	4.0 (3.8–4.8)	<.0001
Ease of receiving instructor guidance	5.0 (4.0–5.0)	4.0 (4.0–5.0)	.02
Suitability for SLE teaching	5.0 (4.0–5.0)	4.0 (3.0–5.0)	.0009

Ratings were collected using 5-point Likert-type ordinal scales (1 = very poor to 5 = excellent; higher scores indicate better performance). Paired comparisons between DRV and 2D monitor were performed using the Wilcoxon signed-rank test. Significance was defined as $p < .05$. DRV = Deep Reality Viewer; IQR = interquartile range; SLE = slit lamp examination.

Secondary outcomes: optic nerve head assessments

Slit lamp photos of various optic nerve heads were assessed with both the DRV and a 2D monitor, including an evaluation of the vertical cup-to-disc ratio and other optic nerve head features. Bland–Altman analysis of cup-to-disc ratio measurements showed minimal bias between the DRV and the 2D monitor across all optic nerves (bias −0.04 to 1.9E-17), with 95% limits of agreement within ±0.3 units (Table 2, Fig. 2), indicating good agreement without systematic bias. Levene's test confirmed homogeneity of variances for cup-to-disc ratio across three of 4 images (image A: $p = .66$; image B: $p = .05$; image C: $p = .43$; image D: $p = .92$), suggesting consistent measurement precision between modalities.

Agreement for disc margin clarity was low ($\kappa \leq 0.30$), whereas disc colour ranged from fair to almost perfect ($\kappa = 0.26–0.83$). Agreement for PPA detection was substantial ($\kappa = 0.71–0.75$) and for tilted disc identification ranged from moderate to perfect ($\kappa = 0.31–1.00$). For images with variable responses, no systematic bias between modalities was detected ($p > .05$ for all comparisons). In images with 100% agreement for PPA (see Supplementary Fig. 2, B and D, online) or tilted disc identification (see Supplementary Fig. 2D online), κ statistics and bias testing were not calculated.

No significant differences were observed between the DRV and 2D monitor for optic nerve margin visibility ($p = .24$) and accuracy of optic nerve colour representation ($p = .054$). However, the DRV provided significantly greater clarity for disc size assessment ($p = .0065$) and cup-to-disc ratio estimation ($p = .016$).

When compared to a glaucoma specialist's reference assessments, cup-to-disc ratio accuracy (within ±0.1 of reference) was 52.5% for the DRV and 72.5% for the 2D monitor ($p = .007$). For PPA detection, accuracy was 86.3% for the DRV and 77.5% for the 2D monitor ($p = .06$). Disc tilt identification accuracy was 72.5% for the DRV and 85.0% for the 2D monitor ($p = .01$). These results are summarized in Table 3.

Table 2—Agreement between Deep Reality Viewer and 2-dimensional monitor measurements of vertical cup-to-disc ratios using Bland–Altman analysis

Image #	Mean bias (monitor−DRV)	95% CI of bias	Lower LOA	Upper LOA
1	−0.015	−0.057–0.027	−0.054	0.029
2	−0.038	−0.11–0.031	−0.10	0.026
3	−0.023	−0.078–0.033	−0.074	0.029
4	1.9E-17	−0.048–0.048	−0.045	0.045

For each image set, the mean bias (monitor−DRV), 95% CI of the bias, and limits of agreement (LOA) are presented. A bias close to zero and narrow LOA indicate strong agreement between modalities. DRV = Deep Reality Viewer; CI = confidence interval.

Discussion

This prospective study evaluates the DRV's teaching utility and task-specific validity for slit-lamp examination of both the anterior segment and the optic nerve head and compares it with a 2D monitor. Prior to this study, the DRV system had demonstrated its advantages in other medical specialties. In otology, a prospective study compared the DRV with a 2D screen for mastoid exploration and with a surgical microscope for cadaveric tasks, including external auditory canal examination, mastoid drilling, and tympanoplasty.[10] The DRV outperformed the 2D display and was

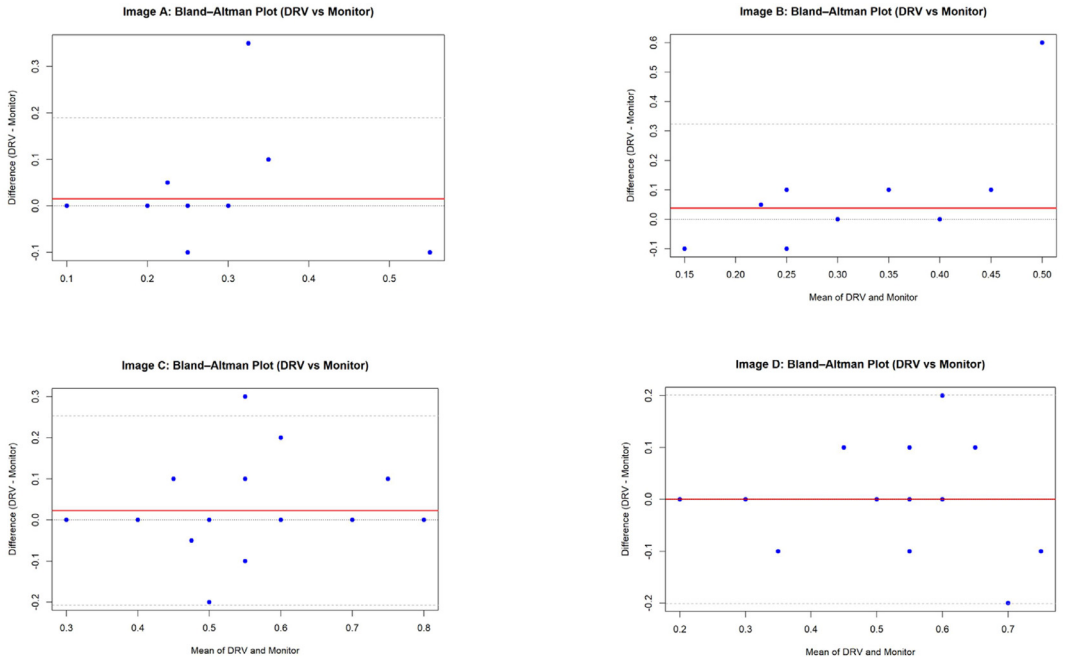


Fig. 2—(A–D) Bland–Altman plots comparing Deep Reality Viewer (DRV) and monitor measurements across 4 image sets. Each plot shows the mean of DRV and monitor values (*x*-axis) versus their difference (*y*-axis). The solid red line represents the mean bias, and dotted lines indicate the limits of agreement. Overall, differences were small and centred near 0, suggesting good agreement between DRV and monitor measurements.

better than the surgical microscope in most tasks. In neurosurgery, another study using AnaVu, a different 3D stereoscopic viewing system, evaluated brain stem anatomy teaching in 152 medical students against a 2D microscope.[10] Stereoscopic 3D viewing was associated with better knowledge integration, and most students preferred 3D stereoscopic over 2D monoscopic visualization. Across different medical specialties, stereoscopic visualization improves spatial learning and anatomical understanding.

In ophthalmology, 3D stereoscopic viewing systems have been impactful in surgical teaching. Platforms like NGENUITY or ARTEVO 800 improve ergonomics, increase depth of field, and enhance the observer experience.[5,11,12] While effective in OR settings, these viewing modalities are often impractical in outpatient or teaching environments. OR-based systems are bulky, require specialized 3D glasses, and lack portability.[5,11] The DRV integrates readily with slit lamps and can be deployed in clinical rooms as a tabletop setup. Its glasses-free design also eliminates the need for polarized eyewear, enhancing accessibility and comfort for medical learners.

Stereoscopic 3D viewing is important in anterior-segment examination because depth perception helps assess conjunctival chemosis or raised conjunctival lesions, localize corneal pathology to the correct layer, estimate anterior chamber depth, identify narrow angles, appreciate iris lesion contour and elevation, and evaluate optic nerve appearance.[13,14] Traditional 2D teaching scopes and monitors lack the stereoscopic vision essential for teaching tasks that depend on depth perception. Therefore, DRV's stereoscopic 3D vision offers a distinct advantage in SLE teaching.

Image quality was significantly better on the DRV. This likely reflects the DRV's design, as it delivers visual information from both slit-lamp eyepieces through 2 dedicated optical channels, rather than a single channel, providing richer detail and minimizing transmission loss for the viewer.[15] These improvements in image quality are consistent with the literature, in which researchers have reported superior visualization with 3D stereoscopic systems.[12]

The DRV's teaching utility was rated higher than 2D monitors for slit-lamp examinations. Participants reported greater confidence in visualizing ocular anatomy. Confidence during learning is associated with better knowledge retention, greater willingness to engage in clinical examinations, and more effective transfer of skills to independent practice.[13] Studies on simulation-based ophthalmology training show that learners report reduced anxiety and increased confidence when training in technologically

Table 3—Diagnostic performance of the Deep Reality Viewer and 2-dimensional monitor for identifying optic nerve head features

Feature	Metric	DRV (%)	Monitor (%)	*P* value
Cup-to-disc ratio*	Accuracy	52.5	72.5	.007
PPA	Accuracy	86.3	77.5	.06
	Specificity	100	90.0	
	Sensitivity	72.5	73.3	
Disc tilt	Accuracy	72.5	85.0	.01
	Specificity	30.0	N/A	
	Sensitivity	86.7	85.0	

*Results were compared with a glaucoma specialist's reference assessment, with cup-to-disc ratio measurements considered accurate if they were within ±0.1 of the reference value. Sensitivity for the monitor could not be calculated because no true-positive or false-negative cases were present. DRV = Deep Reality Viewer; PPA = peripapillary atrophy.

enhanced environments.[14,15] The DRV appears to offer similar benefits. Also, its comparable comfort ratings indicate that it does not add strain on observers, unlike monocular teaching scopes, which often have less favourable ergonomics.[16] This suggests that the DRV system can be integrated into current teaching without causing additional discomfort.

With respect to ONH assessment, the DRV and 2D monitor demonstrated comparable performance. However, the 2D monitor showed better observer accuracy for cup-to-disc ratio and disc tilt. This differs from the study by Lehmann et al., which reported worse observer accuracy for cup-to-disc ratio using 2D images compared with 3D images.[17] In contrast, the study by Sandhu et al. found no significant difference between 2D and 3D images for observer-based assessment of ONH parameters, specifically for cup-to-disc ratio and disc tilt.[18] Taken together with our findings, these results suggest that both viewing modalities likely provide sufficient visual information for ONH assessment, consistent with reports that monocular viewing is adequate for clinical evaluation.[19]

Furthermore, these findings should be interpreted in the context of our cohort, which consisted primarily of medical students. In contrast, studies by Lehmann et al. and Sandhu et al. exclusively utilized residents and practicing ophthalmologists, who had greater experience with ONH evaluation.[17,18] As such, the limited and variable experience of medical students with ONH assessment may have led to inconsistent grading, an effect that may have been further amplified by the relatively small sample size of trainees and eyes, thereby limiting the generalizability of these results. In addition, medical students are typically more familiar with 2D images of the ONH, including fundus photographs and monocular teaching scopes, which may have biased performance against 3D visualization.

Our study also has other limitations. The small sample size limits generalizability and reduces statistical power to detect true differences in preference between the DRV and 2D monitors, specifically for optic nerve assessments. Another limitation is that, to minimize bias, we used static optic nerve images, whereas dynamic examinations might better evaluate the importance of stereopsis and the differences between the viewing modalities for ONH examination. Further, the "acceptable" label at the midpoint (3) of the Likert scale is not entirely neutral, as it has a mildly positive connotation. This may have biased responses upward compared with the use of a more neutral midpoint such as "average" or "neutral." Moreover, the range of the verbal labels (1 = very poor to 5 = excellent) is not equidistant; raters may only rate the top 10–25% of performance as "excellent," with the range of the poorer labels encompassing a wider range of performance.

An important future direction is to conduct longitudinal studies to determine whether the educational benefits of the DRV system translate into lasting improvements in clinical skills, as this and previous studies have demonstrated only short-term benefits in learning and performance only. Cost–benefit analyses comparing the DRV system to other educational investments could also help inform institutional decisions regarding the adoption of this technology. By improving visualization and depth perception during slit-lamp examination, the DRV may be a useful tool in ophthalmology education and benefit learners.

CRediT Author Statement

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jcjo.2026.06.002.

References

1. Bouthour W, Biousse V, Newman NJ. Diagnosis of optic disc oedema: fundus features, ocular imaging findings, and artificial intelligence. Neuro-Ophthalmol Aeolus Press 2023;47:177–92.
2. D'Antona L, McHugh JA, Ricciardi F, et al. Association of intracranial pressure and spontaneous retinal venous pulsation. JAMA Neurol 2019;76:1502–5.
3. Saroya J, Chahal N, Jiang A, et al. Needs assessment for direct ophthalmoscopy training in neurology residency. BMC Med Educ 2024;24:344.
4. Mackay DD, Garza PS, Bruce BB, Newman NJ, Biousse V. The demise of direct ophthalmoscopy: a modern clinical challenge. Neurol Clin Pract 2015;5:150–7.
5. Razavi P, Cakir B, Baldwin G, D'Amico DJ, Miller JB. Heads-up three-dimensional viewing systems in vitreoretinal surgery: an updated perspective. Clin Ophthalmol 2023;17:2539–52.
6. Huang Z, Yang J, Wang H, Pang CP, Chen H. Comparison of digital camera real-time display with conventional teaching tube for slit lamp microscopy teaching. Curr Eye Res 2022;47:161–4.
7. Solyman O, Ahmad M, Arora K, Henderson AD, Carey A. Stereoscopic three-dimensional (3D) slit-lamp photography using a compact 3D digital camera. Indian J Ophthalmol 2021;69:1303–5.
8. Vision TriTeQ. Deep reality viewer. 2025. https://www.vision-triteq.com/drv-d1/. Accessed August 1, 2025.
9. Hind J, Shipton C, Lockington D. A pilot project evaluation of a novel heads-up viewing system compared to desktop

microscopes commonly used for ophthalmic simulation. Eye 2023;37:2830–1.
10. Milner TD, Denton O, Moen CM, Iyer A. Validation of the novel Deep Reality Viewer (DRV) 3D digital stereo viewer in otology surgery. Eur Arch Otorhinolaryngol 2022;279:4839–45.
11. Bawankule PK, Narnaware SH, Chakraborty M, et al. Digitally assisted three-dimensional surgery—beyond vitreous. Indian J Ophthalmol 2021;69:1793–800.
12. Ma L, Fei B. Comprehensive review of surgical microscopes: technology development and medical applications. J Biomed Opt 2021;26:010901.
13. Enoch L, Abraham R, Singaram V. Factors that enhance and hinder the retention and transfer of online pre-clinical skills training to facilitate blended learning. Adv Med Educ Pract 2023;14:919–36.
14. Tooley AA, Hur MJ, Lachman N, Barkmeier AJ. Cadaveric simulation improves ophthalmology resident confidence and preparedness for emergent ophthalmic procedures. Can J Ophthalmol 2021;56:e133–e5.
15. Bansal S, Bhambhwani V. Evaluation of a simulation-based ophthalmology education workshop for medical students: a pilot project. BMC Med Educ 2025;25:153.
16. Arthur D, Babu Kannan N, Sen S, Ramasamy K. Digitally assisted vitreoretinal surgery: a unique surgical teaching tool for beginners. Indian J Ophthalmol 2022;70:477–81.
17. Lehmann MV, Mardin CY, Martus P, Bergua A. 3D vs 2D qualitative and semiquantitative evaluation of the glaucomatous optic disc atrophy using computer-assisted stereophotography. Eye (Lond) 2008;22:628–35.
18. Sandhu S, Rudnisky C, Arora S, et al. Compressed 3D and 2D digital images versus standard 3D slide film for the evaluation of glaucomatous optic nerve features. Br J Ophthalmol 2018;102:364–8.
19. Sharma NK, Hitchings RA. A comparison of monocular and "stereoscopic" photographs of the optic disc in the identification of glaucomatous visual field defects. Br J Ophthalmol 1983;67:677–80.

Footnotes and Disclosure

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