VIRTUAL REALITY: COMING TO A LANE NEAR YOU

VR and its cousin, augmented reality, offer great potential in the realm of eye care.

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Commercial virtual reality (VR) devices have exploded onto the market. In 2016, approximately 87% of VR headsets sold worldwide were mobile-phone–based.1 Stand-alone wireless headsets that don’t need to connect to a PC or smartphone will soon predominate over tethered headsets. Global shipments for the VR and augmented reality (AR) market are expected to reach 7.6 million units in 2019.

Companies in this space include Oculus (the tech firm, not the maker of the Pentacam), Google, HTC, Samsung, Sony, and Lenovo. VR devices have now become affordable, allowing access to just about everyone. They are used in the gaming and entertainment, retail, military, and health care sectors.

Most systems are fully immersive, allowing the user to enter a space that would otherwise be difficult or impossible to enter. Companies can virtually bring in new hires for training, minimizing time and cost spent on travel. Friends separated by hundreds or thousands of miles, domestically or internationally, now have a medium on which to meet and catch up. Surgeons in training can practice unlimited times and be tested on their competence. Current technology suggests a future in which they will be able to operate remotely.

VR’S EFFECTS ON THE EYES

VR devices work by using high powered plus lenses to focus the virtual environment at a set focal distance. Accommodation is therefore fixed, while vergence eye movements are used to take in a field of view that can be up to 110° wide. The dissociation between accommodation and vergence can potentially contribute to visual discomfort in the user. Recent models allow the pupillary distance to be set and employ eye tracking to provide a more accurate and seamless experience.

With the Asia-Pacific region experiencing the fastest growth in VR adoption, there is concern regarding the exacerbation of myopia progression due to prolonged use of these devices, especially in a population that already has a greater than 80% prevalence of myopia in many regions.2 Turnbull and colleagues3 tested the effects of a VR device in young adults. Participants spent
40 minutes each in four environments: VR indoors, VR outdoors, real world indoors, and real world outdoors. In all four environments, there were no changes in phoria, stereopsis, or accommodative amplitude. Choroidal thickness, as a proxy for risk of myopia progression, was found to be thicker after VR device use, suggesting that there is little risk of myopia progression with VR use. Historically, excessive near work raises concerns of progressive myopia due to a lag of accommodation and hyperopic defocus in the retina.

VR head-mounted displays can also affect the tear film. Turnbull et al found that subjects using VR versus conventional desktop computers had increases in outer eyelid and corneal temperatures improving lipid layer grade and noninvasive tear film breakup time. A different group found blink rates to be reduced from 23.95 blinks per minute down to 10.62 with a VR headset, which makes sense with the task at hand. However, the VR headset must act as a moisture goggle, counteracting the evaporation from reduced blink rate.

**USES IN VISION TESTING AND THERAPY**

Traditional in-office testing for visual performance may not reflect real-world challenges. Medeiros and colleagues used an Oculus Rift VR system (Oculus) to evaluate impairment in individuals with glaucoma by presenting VR stimuli. Patients with glaucoma were found to react to movement and rotation more erratically than controls, losing their balance more easily.

Objective glaucoma testing is also possible with a VR-type headset developed by Ngoggle Diagnostics. The company uses what it calls brain-computer interface to noninvasively screen, diagnose, and monitor glaucoma through neural stimulation and feedback. A case-control study in glaucoma found that the device had a sensitivity of 85% and a specificity of 71%, far better than 24-2 SITA standard automated perimetry metrics of mean deviation and pattern standard deviation. The Ngoggle test has many potential advantages over standard perimetry, including better repeatability, less noise, more objectivity, and test duration of 3 minutes per eye.

Vivid Vision has introduced an immersive VR system that incorporates natural gesture tracking as an adjunct to office-based and home-based vision therapy. Common conditions that can be treated with the system include amblyopia, strabismus, and convergence insufficiency. In patients with amblyopia, the stronger eye is given less signal strength until the weaker eye improves to the point at which both images are combined and depth is perceived all the time. Interactive games keep patients engaged. This system has been evaluated in studies published in peer-reviewed journals and presented at meetings.

**AUGMENTED REALITY**

AR takes the real world we live in and overlays digital content and features on top. An AR experience that gained popularity a few years ago was the mobile game Pokemon Go. More recently, the AR game Harry Potter: Wizards Unite has garnered attention. In the automotive world, an example of AR is heads-up display systems that can project a vehicle’s speed into the lower field of view of the driver’s side windshield. In the future, such systems might add digitized color to highlight lane lines when a slight deviation in direction is sensed, or they might project indications of a safe following distance from other cars based on speed and conditions.

The Ngenuity 3D Visualization System (Alcon) incorporates a 3D, stereoscopic high-definition digital video camera with a surgical microscope and a large high-definition screen with AR elements. The surgeon wears 3D glasses to view the screen rather than looking through the oculars of the microscope, a heads-up design that has ergonomic benefits. Because the whole surgical team can see each step of the procedure, all can actively participate and anticipate the surgeon’s needs. The system has customized settings for enhanced viewing. Also, there’s no need to drape and prep the scope.

Oculens ARwear Glasses (Ocutrx) are AR devices designed for use by people with age-related macular degeneration (AMD). Michael Freeman, the CEO of Ocutrx, said he founded the company in 2015 because he was inspired to create an AR device (Continued on page 41)
for his late father who had AMD.10 The AR glasses pair with the user’s digital devices. For individuals with low vision, scotomas in the visual field are first mapped out in the clinic. Then the glasses’ technology fills in what is lost in the scotoma by displaying that visual information just adjacent to the scotoma in areas of remaining functional vision. Testing of an early prototype caused Mr. Freeman’s father to exclaim, “I haven’t seen your nose for years!” These AR glasses can restore independence and quality of life to individuals with AMD or low vision, and they can also be used by these patients’ eye care professionals for remote patient monitoring.

THE FUTURE IS COMING

VR and AR are here to stay. Devices that employ these technologies will be increasingly adopted by the public, and this can create talking points for us to use with our patients and their children. The potential of VR and AR in the medical space is seemingly limitless, and many patients stand to benefit in the short and long terms. What once seemed futuristic in movies such as Minority Report and Iron Man is becoming reality today.


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