Going Digital

Ngenuity 3D Visualisation for Ophthalmic Microsurgery

Figure 1. The camera of the Ngenuity 3D visualisation system being installed on to an operating microscope.

In eye surgery, visualisation of the structures you are operating on is critical for a successful surgical outcome. Until recently, eye surgeons have been forced to use analogue operating microscopes that have changed little since the 1970s. However, a new era has arrived with the introduction of digitally-optimised visualisation systems that provide benefits to both the patient and surgeon, from routine cases through to the most complex eye surgeries.

WRITER Dr Nathan Kerr

Alcon's Ngenuity system consists of four key components: a digital 3D High Dynamic Range (HDR) camera; a 3D 4K 55-inch organic light-emitting diode (OLED) surgical display; a high-speed image processor; and passive polarised 3D glasses. The Ngenuity HDR camera replaces the eye pieces, or oculars, of the surgical microscope. The camera is compatible with all analogue surgical microscopes, which means hospitals do not need to replace their existing equipment when upgrading with the latest digital technology. The camera produces a high resolution, stereoscopic 3D view, at 60 frames-per-second, using complementary metal-oxide-semiconductor (CMOS) sensors which provide low-noise and high-sensitivity imaging. The HDR technology merges an under-exposed and over-exposed image in real-time, providing greater detail and contrast, helping reduce instrument glare and illuminate shadows. The camera does not require alignment, focus, or synchronisation.

Instead of surgeons bending their necks to look through the eyepiece of a microscope, the surgical view is displayed on an immersive 4K, 55-inch display that provides bright and accurate colours in ultra-high definition (UHD; 3,840 x 2,160 pixel resolution). The surgeon and the entire team in the operating theatre wear passive, polarised 3D glasses to recreate binocular disparity, resulting in a stereoscopic 3D view. The surgical display is durable and mounted to a mobile cart containing a high-speed image processor that optimises the image in real time, performs personalised colour and light-temperature adjustments, and records simultaneously in both 2D and 3D. The entire system can be easily moved between different operating theatres with relative ease, even where space is limited.

ENHANCED PATIENT COMFORT AND SAFETY

The highly sensitive HDR camera, combined with real time digital image processing, allows surgeons to operate using very low illumination levels. Even in dim light, the image remains sharp and clear with fine details visible. This minimises light exposure to the patient's eye, resulting in a more comfortable experience for the patient. Additionally, there is a reduced risk of light-induced macular toxicity. This is of particular concern during vitreoretinal surgery, where overexposure for prolonged periods can lead to iatrogenic phototoxicity that could adversely affect visual acuity.[1] In a study comparing light illumination during cataract surgery using analogue microscopes and the 3D digital system, there was a 60.4% reduction in light exposure with the 3D system.[2] In another study of cataract surgery, coaxial light exposure was significantly reduced and visual recovery was more rapid in eyes treated using the 3D visualisation system compared to a traditional analogue microscope.[3]

IMPROVED VISUALISATION

The Ngenuity system has five times greater depth of field compared to an analogue microscope. This means that everything, from the cornea to the posterior capsule, is in clear focus, aiding precision and accuracy to critical steps of the operation. This enables me to operate more efficiently and with greater confidence. With traditional microscopes, as magnification increases, depth of field decreases. The Ngenuity system offers 48% increased magnification while maintaining depth of field and 42%

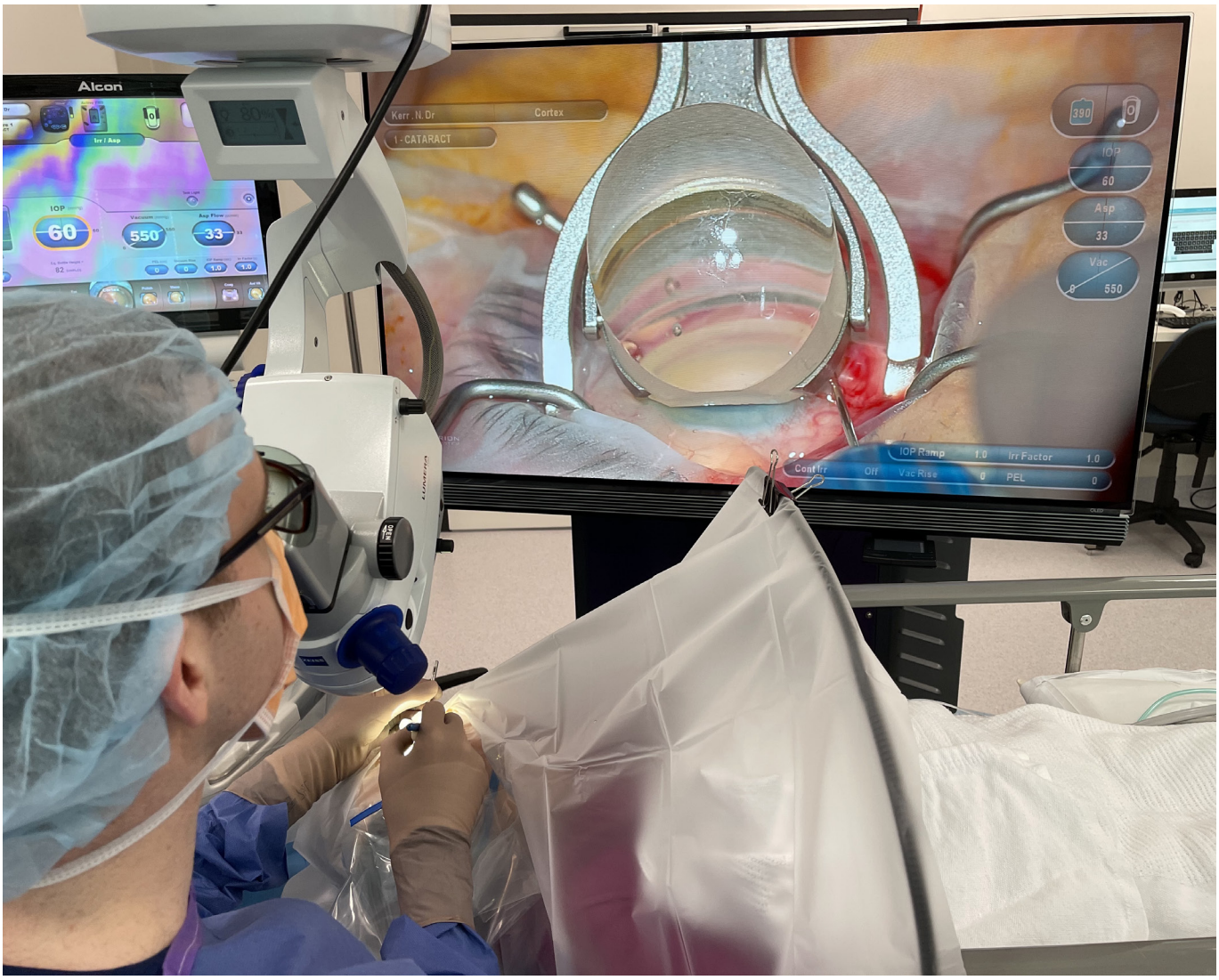

Figure 2. Dr Nathan Kerr performing minimally invasive surgery using the Ngenuity 3D visualisation system.

increased resolution.[4] Additionally, with an analogue microscope, while the centre of the image is clear, the quality of the image degrades towards the periphery, but with Ngenuity there is edge-to-edge clarity. This enhanced visualisation is extremely helpful for intricate and complex microsurgery, such as minimally invasive glaucoma surgery (MIGS). For example, the central outlet of the iStent inject, which must reside in Schlemm canal to function properly, is just 80 µm in diameter. The iStent inject, and other angle-based minimally invasive procedures like Hydrus and iTrack, are performed using a gonioscopy lens. The HDR camera and image processing ensures there is no glare from the lens and that no detail is obscured by shadow. The unparalleled visualisation of the Ngenuity helps me achieve optimal and consistent results for my patients. Digital filters can be used to highlight specific structures, minimising the cost and need for vital dyes.

HEADS-UP DISPLAY

As a glaucoma and cataract surgeon, I am mindful of keeping intraocular pressure (IOP) low and avoiding IOP spikes during ophthalmic surgery, as well as the need to protect the corneal endothelium, especially for patients with Fuchs endothelial dystrophy. The Ngenuity system integrates with the most widely used phacoemulsification system in Australia – Centurion – and displays critical parameters such as IOP, cumulated dissipated energy, vacuum, and aspiration rate in a heads-up display. This enables me to monitor critical surgical parameters and system performance during the operation, without ever taking my eye off the patient. These features are also of benefit to vitreoretinal surgeons who can monitor parameters such as cutter rate and light intensity. The Ngenuity system is based on an open platform system and interfaces with intraoperative optical coherence tomography and endoscopy systems from multiple manufacturers. This centralised and unified view of key data allows surgeons to make informed surgical decisions, with the aim of achieving better patient outcomes.

ERGONOMIC ADVANTAGE

Musculoskeletal disorders are prevalent among ophthalmologists, with many suffering from neck and back pain.[5] Using a 3D visualisation system enables the surgeon to sit upright in a comfortable position, reducing discomfort and pain. In separate studies of Brazilian, French, and Chinese ophthalmologists, all three studies found that ophthalmologists preferred the 3D system and/or reported better ergonomics with Ngenuity.[6-8] Personally, I have found Ngenuity to be a game changer for MIGS. In angle-based surgery, it is necessary to tilt the microscope at least 30-35° toward the surgeon in order to visualise the trabecular meshwork and access

Schlemm canal. This results in an awkward position for the surgeon who must operate with outstretched hands because they are sitting further from the patient. With Ngenuity, I can remain upright and operate with my hands in a neutral, comfortable position, while enjoying a highly magnified and clear view of the angle. Once you have experienced this, you will never want to go back to a traditional microscope.

TEACHING AND TEAMWORK

At the Royal Victorian Eye and Ear Hospital, I supervise and teach fellows who are training to become glaucoma specialists. The introduction of Ngenuity has been transformative as a teaching tool. The system accelerates knowledge transfer by allowing both the surgeon and trainee to share the same view. This allows the trainee to see exactly what I am doing and conversely, it allows me to be more confident and let the trainee do more of a case while remaining fully supervised. The ability to record cases in both 2D and 3D provides a great tool for case review and debriefing. The system allows surgeons to capture videos that can be shown at conferences, providing the audience with an immersive 3D view of the operation.

Lastly, the Ngenuity system results in timesaving and workflow efficiencies. Because all members of the surgical team, including nurses and surgical assistants, have the same view that I have, they can better anticipate what I might need next.

CONCLUSION

The introduction of 3D digital visualisation represents the next evolution in ophthalmic microsurgery. These systems enhance visualisation, reduce light exposure, integrate data from multiple systems, improve ergonomics, support teaching, and unify the surgical team.

Ngenuity improves the surgical experience for both anterior and posterior segment surgeons, with the ultimate goal of achieving the best possible patient outcomes. mi

Figure 3. The Ngenuity 3D visualisation system integrates with existing theatre equipment.

Dr Nathan Kerr is a fellowship-trained glaucoma specialist in Melbourne, Australia. As a recipient of the Bayer Scholarship, he completed a prestigious fellowship at Moorfields Eye Hospital in London. Dr Kerr has special expertise in the surgical management of glaucoma and the use of minimally invasive glaucoma surgery. He serves as a Glaucoma Section Editor for Clinical and Experimental Ophthalmology and is a Principal Investigator at the Centre for Eye Research Australia. He is a consultant ophthalmologist at the Royal Victorian Eye and Ear Hospital and consults privately at Eye Surgery Associates in East Melbourne, Doncaster, and Vermont South. doctorkerr.com.au

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Figure 4. The Ngenuity 3D visualisation system allows for heads up surgery with improved ergonomics and better visualisation compared to a conventional microscope

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