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Surgeons perform world's first operation inside the eye using a robot

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Robot-assisted eye surgery: Professor Robert MacLaren steers the robot in its first live operation. Credit: Oxford University Hospitals NHS Foundation Trust

Robert MacLaren, Professor of Ophthalmology. assisted by Dr Thomas Edwards, Nuffield Medical Fellow, used the remotely controlled robot to lift a membrane 100th of a millimetre thick from the retina at the back of the right eye of the Revd Dr William Beaver, 70, an Associate Priest at St Mary the Virgin, Iffley, Oxford. He is the first patient ever to undergo this experimental procedure.

The Robotic Retinal Dissection Device (R2D2) trial is sponsored by the University of Oxford and funded by the NIHR Oxford Biomedical Research Centre with support from Oxford University Hospitals NHS Foundation Trust, which runs the hospital. Additional funding was provided by Zizoz, a Dutch charity for patients with choroideremia, a genetic form of blindness.

The robot needs to operate inside the eye through a single hole that is less than 1 mm in diameter and it needs to go in and out of the eye through this same hole during various steps of the procedure, even though the eye may rotate.

The device is designed to eliminate unwanted tremors in the surgeon's hand – such as through their pulse – so tiny surgical manipulations can be safely carried out within the eye.

The robot acts like a mechanical hand with seven independent computer-controlled motors resulting in movements as precise as 1000th of a millimetre in scale.

In the case of Father Beaver, the patient for this first operation, a membrane growing on the surface of his retina had contracted and pulled it into an uneven shape. This leads to a distorted image, like looking in a hall of mirrors at a fairground. The membrane is about 100th of a millimetre thick and needed to be dissected off the retina without damaging it.

Surgeons can just about do this by slowing their pulse and timing movements between heart beats, but the robot could make it much easier. Moreover, the robot could enable new, high-precision procedures that are currently out of the reach of the human hand.

The surgeon uses a joystick and touchscreen outside the eye to control

the robot whilst monitoring its progress through the operating microscope. This gives the surgeon a notable advantage as significant movements of the joystick result in tiny movements of the robot.

Whilst robots have been developed for large scale surgery, such as in the abdomen, until now no device has been available that achieves the three dimensional precision required to operate inside the human eye. The device has been developed by Preceyes BV, a Dutch medical robotics firm established by the University of Eindhoven. Over the last 18 months, the Preceyes engineers and the team at the University of Oxford's Nuffield Laboratory of Ophthalmology have worked together to plan this landmark clinical trial. This has resulted in the world first robotic surgery inside the human eye.

On completing the operation, Professor Robert MacLaren said: 'There is no doubt in my mind that we have just witnessed a vision of eye surgery in the future.

'Current technology with laser scanners and microscopes allows us to monitor retinal diseases at the microscopic level, but the things we see are beyond the physiological limit of what the human hand can operate on. With a robotic system, we open up a whole new chapter of eye operations that currently cannot be performed.'

Speaking at his follow up visit at the Oxford Eye Hospital, Father Beaver said, 'My sight is coming back. I am delighted that my surgery went so well and I feel honoured to be part of this pioneering research project.'

Professor MacLaren added, 'This will help to develop novel surgical treatments for blindness, such as gene therapy and stem cells, which need to be inserted under the retina with a high degree of precision.'

The current robotic eye surgery trial will involve 12 patients in total and

involves operations with increasing complexity. In the first part of the trial, the robot is used to peel membranes off the delicate retina without damaging it. If this part is successful, as has been the case so far, the second phase of the trial will assess how the robot can place a fine needle under the retina and inject fluid through it. This will lead to use of the robot in retinal gene therapy, which is a promising new treatment for blindness which is currently being trialled in a number of centres around the world. This follows on from the successful gene therapy trials led by researchers at the Oxford Eye Hospital and includes developing treatments for retinitis pigmentosa, a genetic condition that is one of the most common causes of blindness in young people and age-related macular degeneration, which affects the older age group.

Provided by University of Oxford