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Diary of a cataract surgeon 2045

Claire McDonnell imagines cataract surgery 30 years into the future

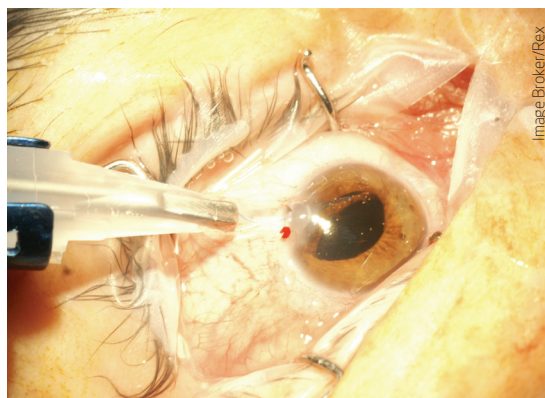
My first patient of the day is a recently retired 80-year-old woman who had been using topical antioxidants for the last 10 years to delay lens opacification,¹⁻⁸ but she was recently required by police to take an eyesight test having driven into the exit lane of a tunnel. She passed the acuity test but did not meet the ocular straylight and contrast sensitivity standards and therefore she is obliged to undergo cataract surgery.

We discuss various options and in the end she chooses the budget option of a bag-in-the-lens multifocal IOL. I explain to her that the corneal incisions, the anterior and posterior capsulotomies and the nucleus chop will be done by an optometrist operating a femtosecond laser and that I will then step in to do the lens removal and IOL implantation. She asks if the implant can be replaced if she does not have perfect vision postoperatively. I explain that the power of IOL required will be calculated based on readings taken during surgery and the IOL will then be 3D printed⁹ and sterilised before being implanted so the likelihood of her having less-than-perfect vision is minimal.

My next patient is late and so I reflect a little on how cataract surgery has changed in the past 30 years. Bag-in-the-lens implantation has virtually eliminated posterior capsule opacification and although it was first conceived in the early 2000s, it only really became widespread when femtosecond laser-assisted anterior and posterior capsulotomies made the procedure less surgically demanding.^{10,11} Optometrists and (in some countries) nurses became more heavily involved in cataract surgery as the size of the elderly population grew and the number of ophthalmologists available to carry out surgery was inadequate for the large patient numbers.¹²

Battery powered

My next patient finally shows. He is in his early 40s and has no significant lens opacification but he is beginning to struggle with close work and wants his vision restored to that of his pre-presbyopic days. I talk him



Phacoemulsification in progress

through acufocus IOLs explaining that they are made from birefringent crystals and that their focus can be changed from distance to intermediate to near, by running an electrical charge through them.¹³ They are powered using biothermal batteries¹⁴ which use the body's own heat for power and the change in focus is triggered based on feedback from sensors attached to the ciliary muscle. He is happy to go ahead with these implants but decides against going for the premium option lenses which include crystals that can change polarisation and therefore act as internal sunglasses.

My next patient cannot afford acufocus implants but does not want multifocals so we discuss another procedure: phaco-ersatz.¹⁵ The optometrist will create a tiny capsulorrhexis with the femtosecond laser and I will carry out phacoemulsification and lens removal with micro-instruments. The capsular bag is then filled with a silicon polymer containing an antimetabolite to prevent posterior capsule opacification.¹⁶⁻¹⁸ The polymer is cured but still retains a Young's modulus similar to the eye's natural lens and so allows the lens to change shape in response to tension on the lens zonules thus restoring accommodation.¹⁹ I take capsular volume measurements from the patient's eyes to check if I can make her emetropic in the distance postoperatively but the machine calculates that she will be approximately -3D myopic in both eyes. However, I see from her medical records (which I access once I complete her iris scan²⁰) that she wears contact lenses, as that is the method used to both monitor her

glaucoma and deliver medication to her eyes, therefore the correction of any residual refractive error can be achieved using the lenses.^{21,22}

Look, no hands

In the afternoon I have surgery in one of our outreach theatres. I remain in our main office and I perform the surgery remotely. I watch the surgery live on camera and robotic hands (with haptic feedback) copy the movements of my own hands which are operating in special gloves.²³ The on-site nurses look after everything else. There was once a hope that this kind of surgery could be used in poorer countries with few trained surgeons, but high equipment costs and a lack of qualified technicians to service the equipment meant that this idea was never realised. Another disadvantage is the fact that there is extra training required to become a remote-hands surgeon compared to that of a real-hands-only surgeon.

Later that day as I drive home from work I listen to a medical podcast and I hear an interesting piece about an ophthalmologist in the Middle East who has carried out cosmetic refractive lens exchange on a patient. The surgeon has implanted an IOL containing a diamond into a patient's eyes. Because the refractive index of diamond is so much higher than that of the aqueous and vitreous, it has created a very strong Purkinje image which gives the appearance of a 'twinkle' in each eye. I marvel at people's vanity and wonder to myself if the world has gone completely mad. ●

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Optics of the future

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