

Editorial

Ophthalmology as a leader in innovation

Introduction: Never a dull day in ophthalmology

It gives me great pleasure to write this article for I truly believe that ophthalmology is one of the most exciting branches of medicine as there is constant research that leads to numerous innovations in technology, pharmaceuticals and surgical techniques. However, for one to fully appreciate this highly dynamic breed of medicine one must have the innate desire to continuously study, research, and learn new surgical techniques. Gone are the days when we did our residency and coasted on the knowledge obtained for the rest of our lives.

In keeping with the theme of this years College of Ophthalmology of Eastern, Central and Southern Africa (COECSA) 2015 Annual Scientific Conference, "Embracing Research and Technology in Ophthalmology" we shall look at the evolution of technology in ophthalmology through the ages and realize that there is never a dull day in ophthalmology.

Darwin on the eye

On mentioning the word "Evolution" we must first of all turn to the grandfather of the theory, Charles Darwin and look into his fascination with the eye. In Chapter VI of his book, "The Origin of Species" Darwin discusses difficulties of the theory by covering organs of extreme perfection and complication. He mentions that, "To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest degree".

He still goes on to make an attempt at how the theory could have led to the formation of such a complex organ when he mentions, "Reason tells me, that if numerous gradations from a simple and imperfect eye to one complex and perfect can be shown to exist, each grade being useful to its possessor, as is certainly the case; if further, the eye ever varies and the variations be inherited, as is likewise certainly the case and if such variations should be useful to any animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, should not be considered as subversive of the theory¹.

Ophthalmology as the first specialization in medicine

From very early times, the ancient Egyptians had argued that each body part was viewed as a separate entity².

In the 19th century a new desire to expand medical knowledge made it necessary for doctors to specialize as it was believed that only specialization permitted the rigorous observation of many cases. Ophthalmology was the very first area of medicine to set itself aside as an

area of specialization. As this happened two journals came into existence the first being, "L'Esculape: Journal Des Spécialités Médico-Chirurgicales." It was edited by a Dr. S. Furnari, a specialist in diseases of the eyes and appeared in June 1839³.

From couching to phacoemulsification

Cataract surgery by "couching" (lens depression) was, without doubt, one of the oldest surgical procedures. This technique involved using a sharp instrument to push the cloudy lens to the bottom of the eye. Maharshi Sushruta, an ancient Indian surgeon, first described the procedure in "Sushruta Samhita, Uttar Tantra", an Indian medical treatise (800 BC)⁴.



Picture courtesy of Arnold Sorsby in A Short History of Ophthalmology

This technique of managing cataracts remained largely unchanged until the 19th century when intraocular surgery saw great revolution with intraocular surgery evolving. Since then we have seen Intracapsular Cataract Extraction (ICCE), Extracapsular Cataract Extraction (ECCE), Small Incision Cataract Surgery (SICS), cataract extraction by phacoemulsification and now femtolaser-assisted phacoemulsification.

All these changes have embraced innovation, research and huge technological leaps and have made use of other fields of progress such as antibiotic and anaesthetic agents development, implant technology, laser physics, and many others. Incisions have gotten smaller from the 180 degree incision used in ECCE to 6mm used in ICCE and SICS to 1.8mm now used in phaco. This has consistently given better and better visual outcomes with fewer complications and faster visual rehabilitation for the patients⁵.

Ophthalmology as leading technological change in medicine

Ophthalmology has been on the forefront of the use of technology in medicine. The first medical application of the laser—which occurred less than a year after its invention—was in retinal photocoagulation. Since then, its effect on ophthalmology cannot be overestimated, as lasers have become abundant in all ophthalmic specialties for both diagnostic and therapeutic devices. Having started off with the Xenon Arc in the 1950s to the Argon laser in the 70s⁶.

Lasers have come to be used on the cornea in refractive surgery and lamellar keratoplasty, on the iris and anterior chamber angle in glaucoma, on the lens during femto-second laser assisted cataract surgery, on the retina for vascular diseases such as diabetic retinopathy and maculopathy, vein occlusions and retinal tumours such as retinoblastoma. It seems there is no end to the applications for which lasers can be applied in the eye.

Old things made new in ophthalmology

Innovation does not only mean inventing new things but also putting new use to old things and ophthalmology has done this with great success.

In the management of chronic diabetic macula oedema new use has been found for Triamcinolone as an intravitreal drug. It has previously made its rounds in medicine having been used by the rheumatologists and orthopaedic surgeons in the management of various joint maladies and calcaneal spurs.

In the treatment of Age-related Macular Degeneration (AMD) we have taken over the use of Anti-Vascular Endothelial Growth Factor (VEGF) agents with Bevacizumab (Avastin) which after being used for years in the management of metastatic colorectal carcinoma and other cancers⁷ is now being used to manage choroidal neovascular membranes in wet AMD⁸.

Various machines have also been developed with ophthalmology at their heart. These include the Optical Coherence Tomogram (OCT), which has now become part of standard care in the management of retina patients despite having been adopted only 15 years ago⁹.

Mobile technology has also found new use in ophthalmology with several applications being developed to facilitate evaluation of patients. The most recent is the Portable Eye Examination Kit (PEEK) system which combines a mobile phone application and lens adaptor that is attached to any smart phone and allows for imaging of the posterior segment of the eye which has the potential for revolutionizing how we screen for common conditions such as diabetic retinopathy and glaucoma by making it easier and more affordable¹⁰.

Breakthroughs in drugs

Other anti-VEGF agents have then come into common use including Ranibizumab (Lucentis) and Aflibercept (Eylea). Age-related macular degeneration was for a long time a devastating disease that affected a large portion of the elderly population rendering them blind with no hope

for effective treatment. Since the inception of the use of anti-VEGF drugs in AMD the outcome has been much more favourable with patients not only reporting no further deterioration in vision but marked improvements in their vision.

Glaucoma is an area where patients in our setting suffered grievously in the 1970s due to an overwhelming lack of medications. Now we have several classes of drugs that are highly effective including the prostaglandin analogues, carbonic anhydrase inhibitors, beta-blockers, alpha agonists and various combinations of the same. These have reduced the need for surgery, augmented the effects of surgery and reduced the rate of visual loss from glaucoma in the long term¹¹.

Breakthroughs in surgical techniques

It was once said that the posterior segment of the eye will forever be inaccessible to the surgeon's scalpel. It was not until 1975 when Machemer designed the single port, multifunctional 17-gauge cutter called the Vitreous Infusion Suction Cutter (VISC)¹². Since then posterior segment surgery has seen the refining of surgical techniques with O'Malley and Heintz describing the use of a 20-gauge 3 port system which became and remained as the gold standard for vitrectomy for the next 3 decades¹³.

Over the past several years, the development of small incision transconjunctival, sutureless Pars plana Vitrectomy (PPV) has led to a major shift in how many diseases are treated in the operating room. In 2002 Fujii *et al*¹⁴ introduced the modern 25-gauge PPV system, while Eckhart endorsed 23-gauge PPV in 2003¹⁵.

Corneal grafting is an area that has also seen much revolution in the techniques used from the traditional Penetrating Keratoplasty (PKP) to the lamellar keratoplasty. Now we are grafting layers using techniques such as Descemet's Stripping Automated Endothelial Keratoplasty (DSAEK), Descemet's Membrane Endothelial Keratoplasty (DMEK) and laser assisted lamellar keratoplasty.

Treating diseases that were incurable

We have already seen the case of wet AMD that was not treatable until the age of the anti-VEGFs. We also have Keratoconus (KC) that was previously only managed with spectacles and contact lenses until it was bad enough to warrant a corneal graft. Now we have technology like collagen crosslinking with Riboflavin and UV and this has greatly reduced the progression of KC and reduced the need for grafting. Corneal regularization prior to crosslinking has enhanced the visual potential of KC patients by reducing the amount of irregular astigmatism and thus allowing better visual outcomes with spectacle correction after crosslinking¹⁶.

Looking forward

Looking into the future we can only wait with baited breath as new technologies take root such as the Bionic Eye and the Brainport.

The Bionic Eye is mainly targeted for patients with retinitis pigmentosa which has for a long time not been amenable to treatment. The technology and the resolution of images have greatly improved over the last couple of years¹⁷. Applications for the Bionic Eye are also being developed for age-related macular degeneration.

The BrainPort V100 is an oral electronic vision aid that provides electro-tactile stimulation to aid profoundly blind patients in orientation, mobility, and object recognition as an adjunctive device to other assistive methods such as the white cane or a guide dog¹⁸.



Photo courtesy of endgadget.com

We look forward to the innovation of more drugs, finer surgical techniques and new applications of our current tools. We must however not just anticipate to be end users of these changes but be part of the change and actively take part in research, focused investigation and innovation and be the next generation of doctors driving progress in ophthalmology.

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