The Changing Face of Cataract and Refractive Surgery

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Cataract surgery, arguably the best operation in the world, has gone through many changes in the last few decades. Many centuries ago, it was of course Susruta in India who first described the operation of couching to eliminate cataract.[1] Subsequently, intracapsular cataract extraction (ICCE) came to the fore. With ICCE, the cataractous lens was replaced by iris supported or anterior chamber lenses, many of which led to problems of corneal decompensation. In the eighties, ICCE was superceded in turn by the much safer planned manual extracapsular cataract extraction (ECCE) with insertion of a rigid intraocular lens implant (IOL). At this point in time, surgical results were excellent when the operation was performed by a skilled, trained surgeon. The wound size was around 11mm and required some 7 stitches to close securely.

In 1967, Charles Kelman published his landmark paper on phacoemulsification (phaco) but it wasn't till two decades later that phaco became widely accepted.[2] This was because the early phaco machines were fairly crude by today's standards and many surgeons were reluctant to embrace new, but unproven technology. One of Arthur Lim's favourite aphorisms, that 'the latest may not be the best' has merit because, being a little circumspect with new technology may save our patients' eyesight.[3] Phaco eventually won out because the technology improved to the point where technology was no longer the limiting factor, the surgeon was; and surgeons could be trained. With ever rising affluence came greater demand for quality vision; this was delivered by the modern day foldable IOL, as responsible as any other factor for the phaco explosion. Wound sizes first came down to 6mm with phaco/rigid IOLs and then to 3.5mm with phaco/foldable IOLs.

Thus in the decade between the early 80s and 90s, there was a threefold decrease in incision size with its attendant benefits of lower astigmatism, greater safety and earlier rehabilitation.

There was however another factor that was fundamental to why phaco has achieved the prominence it has today; phaco allowed the ordinary eye surgeon to achieve results that he could only have dreamt about with ECCE. Once the phaco learning curve had been successfully negotiated, the procedure was dumbed down.

For many years, Arthur Lim as a leader in ophthalmology in the Asia-Pacific, had been reluctant to embrace phaco technology mainly because of the cost implications to the poorer countries.

Furthermore, there was then no published evidence that phaco was superior to ECCE. In 2001 however, in a randomized trial, Minassian et al showed that phaco was indeed superior to ECCE as far as results, complications and even cost were concerned.[4]

Co-axial phaco using a 2.7-3.5mm incision became the gold standard from the 90s through the millennium. This was possible because of the use of injectors for the foldable lenses which allowed sub-3mm incisions and greater sterility (Figure 1).

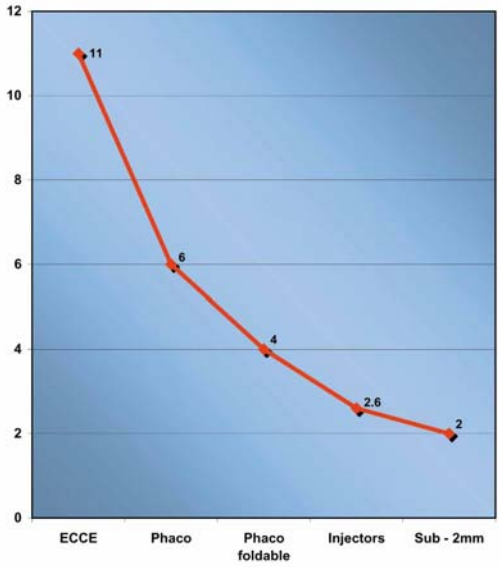

Figure 1. Decreasing incision size with advancing technology

Phaco techniques

Amidst all the ballyhoo regarding ever more complex technological advances in phaco equipment, it is sometimes forgotten that the three fundamental modes of reducing and removing a cataractous nucleus are:

1. Mechanical
2. Vacuum
3. Energy

Newer tip designs and other sources of energy such as laser phaco or water jet (Aqualase) whilst fascinating are but variations on a theme. Similarly, the use of power modulations such as pulse and burst modes. It is arguably more

important to select a technique or piece of technology that is appropriate to the nuclear density of a particular cataract. As can be seen in the following pictures, cataract density varies tremendously (Figure 2).

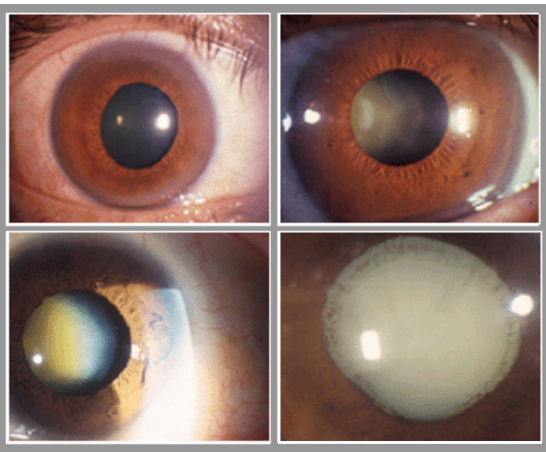

Figure 2. Variable cataract densities require different approaches.

So it was that we could have been excused for sitting on our laurels; after all we could do cataract surgery pretty well through smaller and smaller incisions. Thankfully, amongst us are many innovators and original thinkers who refuse to stagnate in their comfort zones; they constantly raise the ante and make all of us constantly review and improve our techniques. They asked 'Can we do better? How? Is it through better technique? Technology? IOLs?'

Techniques/Technology

Divide and Conquer

The 4 quadrant divide and conquer technique has stood the test of time. First introduced by Sheperd,[5] a recent ASCRS survey confirmed that more than 50% of American surgeons still use this technique routinely. [6] It has the merits of simplicity and reproducibility.

Various Chop Manoeuvres (stop and chop, pre-chop etc)

First introduced by Nagahara,[7] phaco chop utilized mechanical forces to facilitate nuclear reduction resulting in much lower expenditure of energy.

Manual Small incision techniques

Lest we forget that we live in Asia where economic conditions vary widely, cheaper alternatives to phaco are alsoimportant. The skill showed by Dr Albrecht Hennig and his team in the foothills of the Himalaya mountains in Nepal in performing low cost manual small incision cataract surgery results in them performing more than 48,000 surgeries per year.[8]

Bimanual Phaco

Bimanual phaco has achieved disproportionate publicity compared to actual frequency of being performed! A recent survey again by ASCRS showed that less than 3% of US surgeons used it routinely.[9] Some of the limitations of this technique are:

- Flow issues for irrigating chopper
- Learning new technique
- Incisional issues
- 1.4mm incisions but IOLs demand more

Sub-2mm Co-axial Phaco

This revolutionary technique proposed by Dr Takayuki Akahoshi using a new finer irrigating sleeve has allowed standard co-axial phaco to be done through a sub-2mm incision and this may sound the death knell for bimanual phaco.[10]

Incision size and Implant Developments

At the same time as the phaco incision was shrinking, there was an explosion in intraocular lens implant design. Whilst some of these changes were just evolutionary modifications, eg materials, haptic designs, edge modifications, blue filters and injector designs, there were other more revolutionary changes. These major advancements include aspheric optics, accommodative IOLs, pseudoaccommodative or multifocal IOLs and toric IOLs.

Presbyopia has long been recognized as the holy grail of ophthalmology; all manufacturers direct significant effort and research funding to perfecting an IOL capable of addressing surgical or physiological presbyopia.

As these newer lens designs jostle for their place in the sun, it is difficult to imagine that they will be incorporated in the very thin IOLs capable of being implanted through sub-2mm incisions.

Refractive Surgery and the Cataract Surgeon

Over the past decade, refractive surgery has assumed such proportions that it has had an inevitable impact on cataract surgeons; indeed, the cataract surgeon can ill-afford to ignore or not keep up with developments in refractive surgery.

So what have we learnt from refractive surgery? Firstly, quality of vision is not to be taken for granted; that 6/6 or 20/20 may not be enough. Assessing this quality of vision is also important whether it be by questionnaires or contrast sensitivitystudies.

Incorporating wavefront technology in IOL design may therefore better our patient outcomes as far as quality of vision is concerned. Indeed all the major manufacturers have come out with higher order aberration (HOA) reducing lens implant designs.

Bioptics, or the marriage between cataract and refractive surgery to modify cataract surgery outcomes is going to assume ever greater importance as the use of pseudoaccommodative IOLs increases. Residual myopia, hyperopia or astigmatism negates the effect of pseudoaccommodative IOLs and their correction by LASIK will allow us to control our outcomes with far greater precision. Indeed, it may be that the use of bioptics will obviate the need for toric IOLs, at least in the hands of cataract surgeons who also do refractive surgery.

Accommodative IOLs have been around for a few years now and in general they have been found to be wanting as far as the amount of available 'add' is concerned. This is not really surprising when we look at some very elegant studies that have been done by Paul Kaufman's group in which centrally stimulated accommodative effort in young and old monkeys showed that there was little change in ciliary body excursion and lens shape.[11] With an aging accommodative system in most cataract patients, it seems counter-intuitive to rely on a flagging motor system to move an accommodative IOL.

Pseudo-accommodative lens implants have been around for some years but there have been problems with insufficient 'add' and also night time glare and haloes. Realisation of these limitations has led to the new generation of pseudoaccommodative IOLs typified by the Restor IOL from Alcon and the Tecnis diffractive IOL from AMO. The Restor lens incorporates the blue filtering technology that may reduce macular damage from blue light hazards and the Tecnis multifocal lens incorporates aspheric optics.

We have done a small study in Singapore and found that at one month, of 45 patients who had a Restor IOL implanted 88% were able to see 6/9 and 93% read N6 or better unaided. Those who were unable to achieve these levels of vision had residual refractive errors or other previously undetected pathology. 93% of these patients did not use glasses at all.

Figure 3. Convergence of cataract and refractive surgery

Future IOL designs

This is an exciting area and many eyes are watching to see what transpires. Phacoersatz or lens refilling as worked on by Parel and his group holds potential.[12,13] Light adjustable IOLs, changeable shape IOLs and dual-optic accommodating IOLs are other possibilities.

Cataract and Refractive Surgery

There is an inexorable convergence of cataract and refractive surgery today (Figure 3).

Refractive lens exchange is gaining ground in the USA and Bioptics is also growing in importance. An unavoidable issue for cataract surgeons is accurate biometry in cataract patients who have had previous refractive surgery. Conventional ways of measuring true corneal powers are imprecise after LASIK and by a combination of the history method and topography, we try and compute a reasonably accurate IOL to implant. Newer topographers eg the Pentacam may allow more accurate keratometry readings.

Conclusion

These are exciting times we live in. Cataract surgery and refractive surgery have developed apace such that our patients now have choices available such that they can see well without the use of glasses. Getting close to this objective means that we are taking a step closer to reaching the Holy Grail.

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