

Is Femtosecond Technology the Future of our Cataract Surgery?

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INTRODUCTION

Techniques and technology for modern-day cataract surgery have taken quantum leaps over the past several decades. We appreciate today's technology and innovations since we know how it all started. If we look back at how our profession dealt with cataract removal a century ago, fifty years ago, or even ten years ago, we will realize that the refinement of technology and surgical techniques in cataract surgery is one of the greatest success stories in the annals of medicine.¹ Cataract surgery today remains one of the most successful and commonly performed procedures worldwide.²

From ECCE to Phacoemulsification

In the latter part of the last century, we accomplished the full transition from extracapsular cataract extraction (ECCE) to small-incision surgery. Over the years, we have refined our surgical techniques to a point where we could remove the cataract through a very small, nearly astigmatically-neutral incision. But none of these surgical refinements would have been possible without a parallel rise in the technology surrounding them. From the first phacoemulsification machine introduced by Dr. Charles Kelman in 1967, we now have 4th and 5th generation phaco machines that help us deliver excellent surgical results with the least amount of trauma to the eye.³ And of course, from the first rigid intraocular lens (IOL) implanted by Sir Harold Ridley in 1949, advanced-technology IOLs customized toward the patient's needs have become available in our daily practice. What then, is next in our never-ending quest for "perfect vision" after cataract surgery?

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More of the same—nearing the theoretical limits of phacoemulsification technology and techniques

Essentially, we still want more of the same things and we want to make them even better, as we reach the summit of phacoemulsification technology and techniques. We want more and more IOL position predictability in order to achieve our target refractions. To do that, we want to create consistently reproducible capsulotomy size and shape.⁴ In addition, we still want consistently reliable corneal incisions and arcuate incisions to control astigmatism.⁵ And finally, we still want to keep reducing surgical trauma inside the eye during surgery, resulting in clear corneas immediately and thereby maintaining the "wow factor" in our patients.⁶

From a technical and engineering standpoint, we may already be reaching the limits of what phacoemulsification machines using ultrasound power can do. Most of the newer generation phaco machines, in the hands of a capable surgeon can deliver excellent surgical results with the least amount of ultrasound damage to the corneal endothelium. But one can only do so much tinkering with phacoemulsification settings along the physical limits of ultrasound energy. And from a surgical viewpoint, we may also be reaching the limits of what human hands can do. We have shown that we can do fairly round (but not perfect) anterior capsulotomies, and fairly consistent (but not always) corneal incisions. Where do we go from here?

And so the femto wars begin...

The so-called "femto wars" actually began many

years ago. We know that this technology was first explored for refractive surgery in order to create better corneal flaps without the use of a microkeratome.⁷⁻⁸ And in time, that branch of our profession eventually adopted femto-created flaps as the standard for laser-assisted-in-situ keratomileusis (LASIK) surgery. Chronologically, radial keratotomy (RK) was soon followed by photorefractive keratectomy (PRK), which was soon replaced by microkeratome LASIK. Today, more than 80% of LASIK flaps in the United States are created using the femtosecond laser, and refractive surgeons are finding more and more uses for the femtosecond laser in various types of cornea and refractive surgeries.⁹

Recent applications in cataract surgery have demonstrated that the femtosecond laser can achieve consistently reproducible capsulotomy size and shape, lens fragmentation, and corneal incisions.¹⁰⁻¹³ In short, we are trying to “automate” many of the human steps involved in cataract surgery with the use of femtosecond technology and expect to see a theoretical reduction in human error and variability. Are we now witnessing in cataract surgery the same historical route taken by refractive surgery?

Currently, there are four companies offering the femtosecond platform for cataract surgery: the Lens AR Laser System (LensAR, Inc., Orlando, FL), the Victus Femtosecond Laser Platform (Technolas Perfect Vision/Bausch + Lomb, Rochester, NY), the Catalys Precision Laser System (OPTIMEDICA, Sta. Clara, CA), and the Alcon LenSx (ALCON Laboratories Inc., Fort Worth, TX)—nearly all of which have penetrated the local market.

Historical perspectives on the adoption of new technology in our local practice

For many of our local faculty teaching phacoemulsification surgery today, the journey began during the mid to late 90’s. At the time, phacoemulsification represented less than 1% of cataract surgeries done in the country. The culture of ECCE was so ingrained in our residency training and clinical practice that few people believed phacoemulsification would one day supplant ECCE as the gold standard for cataract surgery locally, as it eventually did in the United States. Fast-forward 15 years later and nearly every ophthalmology graduate in the country now routinely perform phacoemulsification, as phacoemulsification machines have become ubiquitous in hospitals and ambulatory

surgical eye centers. Today, femtosecond cataract surgery is virtually in the same status where phacoemulsification was 15 years ago, i.e., less than 1% of cataract surgeries done in the country today are femtosecond-assisted. Will it follow the same historical path as phacoemulsification did? That is currently the half-a-million dollar (cost of the femto machine) question.

It is interesting to note that many of the counter-arguments put forth by local ophthalmologists a decade ago on the need to shift from ECCE to phacoemulsification are making a comeback. At the time, it was not uncommon for many local practitioners to shy away from shifting to phacoemulsification simply because they were confident enough in their ECCE results. And since our collective skills in phacoemulsification surgery then were still raw and had yet to be refined, many ophthalmologists likely produced ECCE results that were “just as good as phaco” and did not see the urgent need to shift techniques. In the ensuing “battle” between ECCE and phacoemulsification of the last decade, we all know which technique came out on top, as we have come to realize that a well-performed phacoemulsification is far superior than ECCE.¹⁴ Can we currently argue that our phacoemulsification is “just as good as femto” and, therefore, see no urgent need to shift techniques? Déjà vu.

Also at the time, phacoemulsification machines were considered expensive relative to all our other ophthalmic equipment, and a doubtful return-on-investment (ROI) was a concern. Local ophthalmologists were also worried that patients might balk at the extra expenses incurred by choosing phacoemulsification over ECCE. Again, local history told us that if superior technology was made available, the demand would come and patients were willing and able to shell out the extra expense for premium eye care.

Finally, the learning curve associated with phacoemulsification training at that time discouraged many local surgeons from immediately adopting the technique. And in fact, during the early days of our phaco learning, we tried to avoid the “difficult cataracts” (brunescent, hypermature, intumescent cataracts, presence of zonolysis, non-dilating pupils, low endothelial cell counts, etc.) and would quickly find any reason to do ECCE instead. But as we collectively refined our surgical techniques over the years, we eventually found out that with the proper

techniques and instrumentation, we can indeed perform good phacoemulsification surgery in practically any cataract case presented to us. In due course, the learning curve shortened especially for the younger generation of phaco surgeons who have benefited from the teachings of early adopters of phacoemulsification in the country. Currently, the learning curve in shifting from phacoemulsification to femtosecond-assisted cataract surgery is probably even shorter.¹⁵⁻¹⁶ If one can do good phacoemulsification surgery, then the transition to femtosecond-assisted surgery will likely be faster. And as the sharing of techniques accelerates our skills in femtosecond-assisted cataract surgery, we are now using femtosecond technology for difficult or complicated cataract cases that were initially thought undoable when this technology was first introduced for cataract surgery.¹⁷

The next phase of the femto wars is underway

In the early years of the “femto wars”, the battle was essentially a race to get approval from the European CE and US FDA for various applications of femtosecond technology in cataract surgery. The Alcon LenSx, currently the most commercially successful among the femtosecond platforms globally, was the first femtosecond machine approved in the United States for all three applications in cataract surgery, i.e., capsulotomy, lens fragmentation, and corneal incisions including arcuate incisions. However, the other femtosecond platforms did not take long in reaching their own approvals and have since gained similar traction commercially.¹ By late 2011, over 7,000 cases had been performed using the Alcon LenSx, with 180 surgeons from 20 different countries utilizing this machine in their daily practice. In a span of less than two years, this number quickly ballooned to 250 machines in 56 countries, with more than a thousand surgeons combining for a total of over 100,000 procedures (Alcon LenSx Clinical Training Records). That, truly is, exponential growth. Closer to home, after the first commercially available femtosecond cataract machine was installed at a local eye center in October of 2011, another three or four femtosecond cataract platforms from different companies have been or are being installed in the country as of press time.

The second wave of “femto wars” will likely involve more improvements in these first generation machines, as well as lowering the cost of incorporating them in our clinical practice factoring in the cost

and maintenance of the machine and added cost to the patient. This second wave will also involve enhancements that incorporate refractive and cataract capabilities, i.e., one machine that can be used both for cataract surgery and LASIK flaps. In addition, “mobile” femtosecond cataract machines may be offered by enterprising individuals or companies that can bring this technology to your doorsteps on-demand, without having the need to purchase one for your own operating room.¹⁹

So is femtosecond technology the future of cataract surgery in the Philippines?

The future looks really exciting for cataract surgeons in the Philippines. And if we go by the history of phacoemulsification adoption in the country, it may be safe to assume that femtosecond-assisted cataract surgery will eventually follow a similar route, albeit a slower one than our shift from ECCE to phacoemulsification. A recent PubMed search on femtosecond assisted cataract surgery revealed few published literature so far, from one article back in 2005 to 57 articles as of June 2013. But make no mistake. It is happening. It is here.

Currently, the main stumbling block to mass adoption is still the cost of purchasing and maintaining the machine, as well as the added expenses to the patient. However, as the “femto wars” drag further on in the next few years, the ultimate beneficiaries will eventually be ophthalmologists and their patients as competition and rivalry among various femtosecond cataract platforms bring the cost down. The future of our cataract surgery clearly looks bright. I say let the “femto wars” carry on.

Editor's Note: The author has no financial or proprietary interest in any of the machines mentioned in this article. He has received travel assistance from Allergan, Microlab/Zeiss, and Alcon for talks given locally and abroad. He was also a co-investigator for various clinical trials with the LenSx from 2011-2012.

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