Laying the Myth or reality

Digitalization enhances cataract surgery?

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The primary goal of cataract surgery is to provide patients with their best possible vision by removing the opacified lens and implanting an intraocular lens (IOL). Regardless of the type of implant used, achieving the targeted refractive outcome after cataract surgery is a multistep process that involves obtaining accurate preoperative measurements, selecting a properly powered IOL, and correct implantation of the lens intraoperatively. With these many steps, planning and executing cataract surgery is a time-intensive process during which there are multiple opportunities for errors being made.

Results of the 2022 ESCRS Clinical Trends Survey show that cataract surgeons see digitalization of cataract workflow as a solution for overcoming the above-mentioned issues.[1] According to the survey, surgeons agree that digital operating rooms bring advantages for improving efficiency and workflow, shortening procedure time, and improving surgical outcomes and safety, as well for improving surgeon comfort during the procedure.

In this interactive supplement, leading surgeons share their experiences with and describe the advantages of cataract surgery digitalization. Their narratives might dispel any myth or concern that changing an existing workflow and adopting to a new system involves too much time and effort and establish as reality that digitalization can truly enhance the planning, performance, and outcomes of cataract surgery.

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part 1

Part 1: Streamlining the cataract workflow from preoperative assessment to post-surgery

Increasing efficiency through digitalization

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Coping with the workforce demands associated with the increasing number of patients needing cataract surgery places a burden on surgeons and staff in the clinic and operating room and highlight interest in tools that can streamline preoperative and intraoperative workflow. Importantly, any strategy implemented to gain a benefit of increased efficiency should at least preserve and better yet also improve surgical safety and efficacy.

In our high volume university hospital setting, we have looked at the use of a digital workflow system as a solution for enhancing efficiency while maintaining our commitment to delivering maximum care. Our experience shows that it results in time savings throughout the entire cataract surgery journey along with excellent surgical results (Video 1).

Video 1. Streamlining the cataract workflow

The IOLMaster® 700 from ZEISS is the entry point into the digital workflow. Biometry data acquired with the ZEISS IOLMaster 700 can be seamlessly imported to EQ Workplace® from ZEISS. The latter platform is a central hub that offers convenient access to our patient data. It also allows surgeons to do IOL power calculation remotely. The system contains a full complement of modern power calculation formulae, and relevant data for each formula are automatically populated into the appropriate fields. After selecting the IOL model and power, the application gives me the convenient opportunity to automatically order the lens by email.

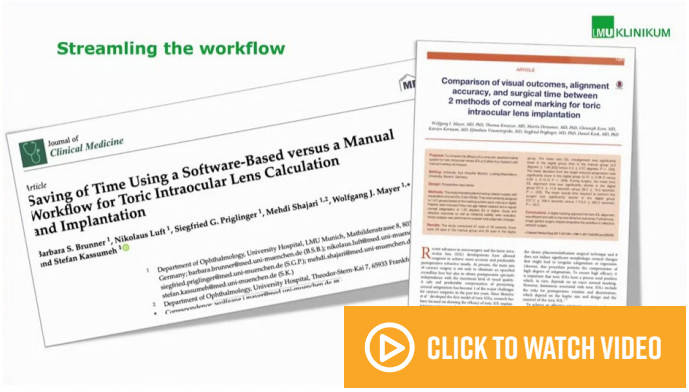
On the day of surgery, the patient's data and reference image acquired with the ZEISS IOLMaster 700 are digitally transferred to my ZEISS surgical devices in the OR. The electronic importation saves time by eliminating the need to upload data manually or with a USB memory stick, avoids the potential for transcription errors that can occur with manual data entry, and makes it unnecessary to bring printouts into the OR.

ZEISS FORUM®, another component of the digital workflow system, is an ophthalmic data management software program that connects these various technologies to streamline processes and that serves us from the point of data acquisition at the beginning of the cataract surgery journey and into the planning, intraoperative, and postoperative phases.

Documenting efficiency

In a prospective study published in 2017, we reported that using ZEISS CALLISTO eye® for digital guidance of toric IOL implantation had advantages for significantly reducing overall surgical time and significantly improving alignment accuracy.[1] Taking our research a step further, we subsequently conducted a study comparing time spent for surgical planning and in the OR in toric IOL procedures performed using ZEISS EQ Workplace versus a conventional manual approach for data collection and transfer (Video 2).[2]

Video 2: Time saving using a digital workflow



The results of our more recent study showed digitalization had benefits for improving both preoperative and intraoperative workflow efficiency. We documented that the digital approach was associated with statistically significant time savings for each of the diagnostic and surgical steps we analyzed that together translated into a total time savings of about 4 minutes per case (Figure 1). Consistent with our previous study, we also found that use of the digital approach for guiding IOL alignment was associated with excellent results when analyzing surgical outcomes that included IOL alignment accuracy, cylinder reduction, prediction error, and visual acuity.

Figure 1. Using a digital workflow for planning and performing toric IOL surgery increased efficiency overall and for all steps

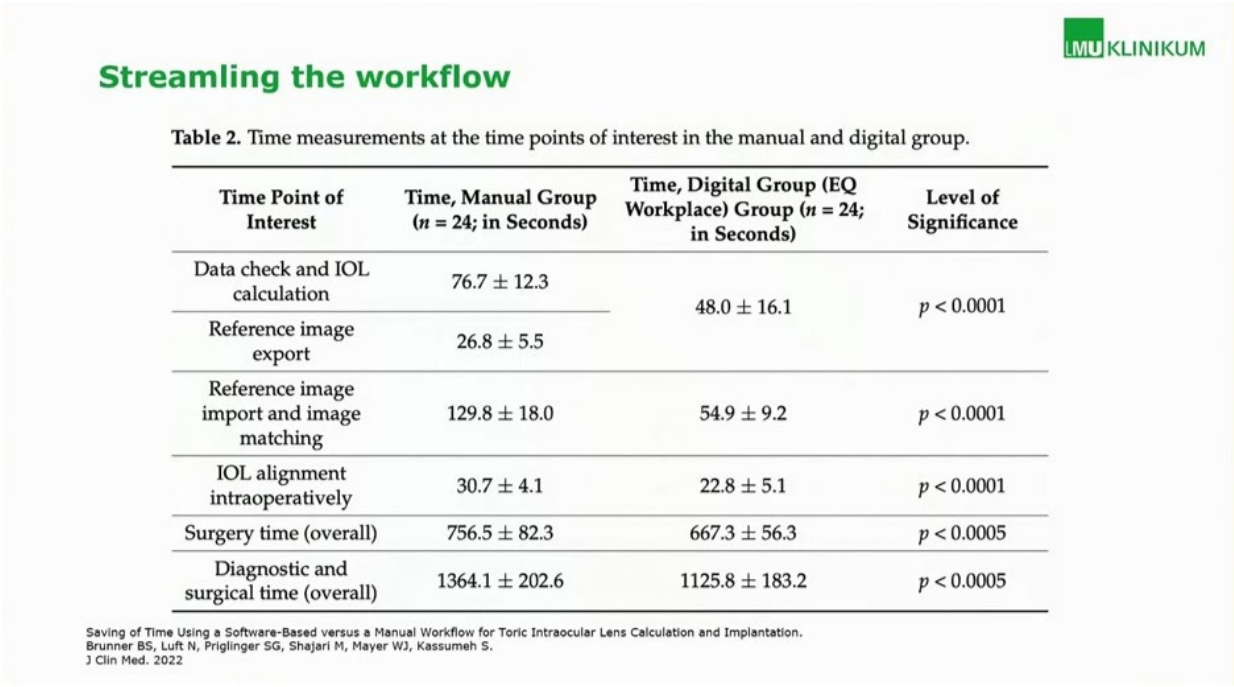


Table 2. Time measurements at the time points of interest in the manual and digital group.

Time Point of Interest	Time, Manual Group (n = 24; in Seconds)	Time, Digital Group (EQ Workplace) Group (n = 24; in Seconds)	Level of Significance
Data check and IOL calculation	76.7 ± 12.3	48.0 ± 16.1	$p < 0.0001$
Reference image export	26.8 ± 5.5		
Reference image import and image matching	129.8 ± 18.0	54.9 ± 9.2	$p < 0.0001$
IOL alignment intraoperatively	30.7 ± 4.1	22.8 ± 5.1	$p < 0.0001$
Surgery time (overall)	756.5 ± 82.3	667.3 ± 56.3	$p < 0.0005$
Diagnostic and surgical time (overall)	1364.1 ± 202.6	1125.8 ± 183.2	$p < 0.0005$

Saving of Time Using a Software-Based versus a Manual Workflow for Toric Intraocular Lens Calculation and Implantation.
Brunner BS, Luft N, Priglinger SG, Shajari M, Mayer WJ, Kassumeh S.
J Clin Med. 2022

Enabling the task of optimization

Optimizing refractive and functional results for patients undergoing cataract surgery is an ongoing process that should include consideration of the need for updating the values for lens constants and surgically-induced astigmatism used in IOL power calculations. ZEISS EQ Workplace also facilitates this task of optimization.

Postoperative data for corrected and uncorrected visual acuity, sphere, cylinder, and axis entered for individual patients into the postoperative surveillance screen are uploaded into ZEISS FORUM with the click of a button. Whenever I choose, I can easily select from this database a series of recent cases for analysis. Then, with another click, the calculations are quickly completed (Video 3).

Video 3: Post-operative optimization

Conclusion

Digital technologies and seamless data workflows increase efficiency throughout the entire cataract surgery journey (Figure 2). Our formal analyses prove that when implanting toric IOLs, the use of a digital workflow results in significant time savings compared to a conventional manual workflow and excellent outcomes. From a practical perspective, these benefits allow for increased productivity, which can help surgeons meet the growing demand for cataract surgery services, and also make for happy patients.

Figure 2. Benefits of a digital workflow for cataract surgery

part 1

Part 1: Streamlining the cataract workflow from preoperative assessment to post-surgery

Digital planning and IOL power calculation for toric IOL surgery

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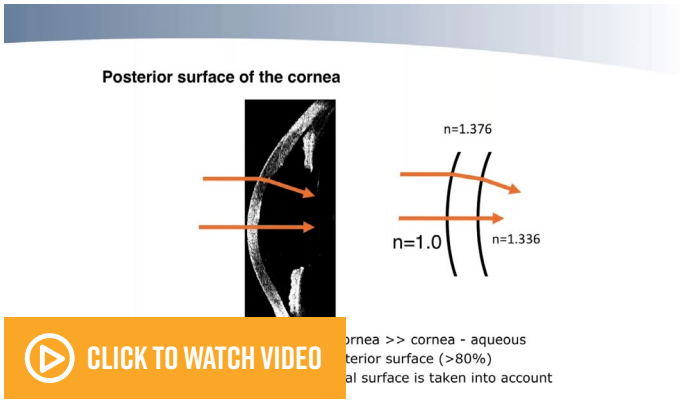
Allowing patients to enjoy independence from glasses after cataract surgery depends on effective correction of both sphere and cylinder. Importantly, at least one-third of eyes are affected by visually significant corneal astigmatism.[3] Toric IOL implantation is accepted as a safe and effective method for astigmatic correction during cataract surgery, and use of toric IOLs has been increasing.[4] Compared with procedures performed with a standard non-toric IOL, however, planning and executing cataract surgery with a toric implant is a little more time-consuming and poses some additional challenges for achieving the targeted refractive outcome. Having a smooth and efficient workflow for obtaining corneal measurements, performing IOL power calculation, ordering IOLs, and guiding proper alignment is important for helping surgeons overcome these issues.

Residual astigmatism after toric IOL surgery can occur for multiple reasons, but according to our research, inaccurate measurement of preoperative corneal astigmatism is the main source and is followed by implant misalignment.[5] Precise assessment of preoperative corneal astigmatism requires the use of reliably accurate technology and accounting for posterior corneal astigmatism (PCA). Although IOL misalignment can occur as the result of implant movement postoperatively, incorrect positioning intraoperatively is the more common underlying cause.[5] Utilizing the digital workflow described by Prof. Wolfgang Mayer in the above section addresses these issues and offers additional advantages for increasing workflow efficiency and surgical accuracy.

Considering PCA

The importance of including the contribution of the posterior corneal surface to corneal astigmatism when performing toric IOL power calculations has been recognized for many years (Video 4). Research reported by Dr. Doug Koch and colleagues in 2012 showed that ignoring PCA in toric IOL cases could lead to undercorrection in most eyes with against-the-rule anterior surface astigmatism and overcorrection in eyes having with-the-rule anterior surface astigmatism.[6]

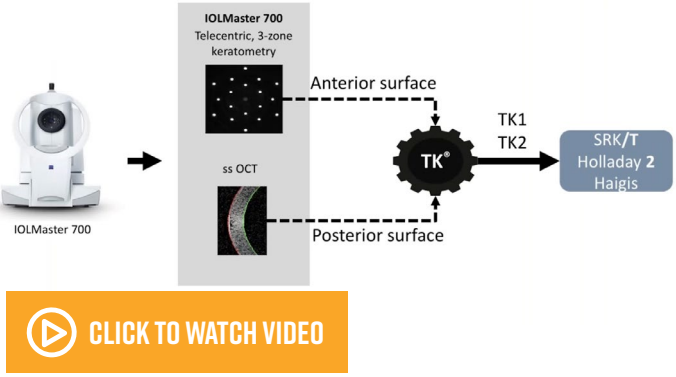
Video 4. Why is the posterior surface of the cornea important?



Accounting for PCA in toric IOL power calculations can be performed using either the measured values (anterior and posterior radii and pachymetry) or by using formulae that use an estimated value for the posterior surface. Results from various research groups differ regarding whether measuring or estimating the posterior surface of the cornea is preferred. There are two explanations for this lack of agreement. First, recent improvements in methods for corneal measurement methods have led to better results when using the measured values. Second, the estimated values for the posterior cornea include not only the estimation for the posterior surface, but also a corrective element for other errors. Therefore, using measured PCA for toric IOL calculations is more likely to be the standard for the future.

Posterior corneal astigmatism can be directly measured using Scheimpflug, OCT, and other diagnostic imaging technologies. With the ZEISS IOLMaster 700, however, PCA is directly measured during routine biometry, avoiding the need for additional imaging (Video 5).

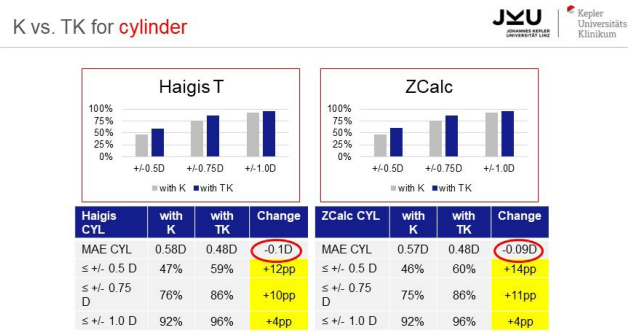
Video 5. Case examples



The ZEISS IOLMaster 700 is a swept source optical coherence tomography biometer that analyzes the anterior surface of the cornea using telecentric, 3-zone keratometry along with corneal thickness and the posterior corneal surface with swept source OCT technology. The data are then combined to Total Keratometry (TK), which is the vector sum of the front and back surface astigmatism. Because TK is comparable to the mean keratometry value, it can be used for toric and non-toric IOL calculations. This represents another benefit of using the ZEISS IOLMaster 700 with TK as not all power calculation formulae allow for direct input of the PCA value measured with other technologies.

A study we conducted analyzing outcomes data from 49 eyes that underwent toric IOL surgery showed that using TK for IOL power calculation instead of standard keratometry resulted in higher prediction accuracy and a higher percentage of patients with ≤0.5 D of residual cylinder (Figure 3).[7]

Figure 3: Outcomes data from 49 eyes with toric IOL surgery that shows higher prediction accuracy using TK[7]



Haigis CYL	with K	with TK	Change
MAE CYL	0.58D	0.48D	-0.1D
≤ +/- 0.5 D	47%	59%	+12pp
≤ +/- 0.75 D	76%	86%	+10pp
≤ +/- 1.0 D	92%	96%	+4pp

ZCalc CYL	with K	with TK	Change
MAE CYL	0.57D	0.48D	-0.09D
≤ +/- 0.5 D	46%	60%	+14pp
≤ +/- 0.75 D	75%	86%	+11pp
≤ +/- 1.0 D	92%	96%	+4pp

In addition to cases involving toric IOL implantation, TK provided by the ZEISS IOLMaster 700 has important value for optimizing the accuracy of IOL power calculations in eyes with a history of corneal refractive surgery for which a refractive surprise is likely when using anterior keratometry alone.

Digitalization for improving accuracy and efficiency of toric IOL implantation

As mentioned earlier, IOL misalignment due predominantly to incorrect positioning intraoperatively is the second most common cause of residual astigmatism after toric IOL surgery. [Hirnschall 2020] Manual axis marking adds an additional step on the day of surgery and can result in IOL misalignment as the ink marks lack

precision and can fade or even disappear during surgery. [Rombold] As reported in the studies described by Dr. Mayer and other researchers, the use of digital tools for cataract surgery enables accurate toric IOL alignment while simultaneously increasing workflow efficiency.[1,2,8,9]

Conclusion

My use of toric IOLs for correcting astigmatism during cataract surgery has increased significantly over the last few years. To deal with this higher work load it is helpful to have a digital workflow that increases efficiency at every step of the surgical journey from preoperative evaluation to the planning stage and into the operating room. In addition to saving time, approaching toric IOL surgery with a digital workflow has advantages of eliminating errors that can occur with repeated manual data entry and provides a more reliable method for guiding accurate IOL alignment compared to manual marking.

Optimizing predictability of refractive outcomes in cases involving toric IOLs also requires taking into account the contribution of the posterior corneal surface to total corneal astigmatism when performing the IOL calculation, and my preference is to use a direct measurement of PCA rather than an estimation. The ZEISS IOLMaster 700 meets this need and does so efficiently with its integrated Total Keratometry and through seamless data transfer to software for power calculation using the latest formulas.

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part 2

Part 2: The digital operating room

Digitalizing my cataract surgery workflow

LIEM TRINH, MD

Hospital CUF, Lisbon, Portugal

For several years, I have been taking advantage of the benefits of a digital workflow achieved by the connectivity between diagnostic and surgical technologies.

Video 1. My digital cataract workflow – Connectivity from diagnostic to surgery

The process begins with the automatic transfer of the biometry measurements obtained with the ZEISS IOLMaster 700 to the data management software (ZEISS FORUM). Using this software, I can conveniently perform IOL calculations remotely with our surgery planning tool - ZEISS EQ Workplace (see chapter 1 for more information). On the day of surgery, all the data required to perform the procedure are then seamlessly available at ZEISS CALLISTO eye in the operating room. ZEISS CALLISTO eye is therefore the integral component that connects my preoperative and surgical workflow (Video 1). Utilizing this digital data pathway in my clinic saves time and avoids transcription errors that can occur with manual data entry.

The launch of QUATERA® 700 from ZEISS added another component to my digital operating room suite and brought it into a new era. By centralizing data communication within the OR, ZEISS QUATERA 700 creates a complete system for connectivity and further enhances our workflow efficiency (Figure 1).

Figure 1: Addition of the ZEISS QUATERA 700 phacoemulsification unit to the cataract workflow creates a complete integrated platform for case management throughout the cataract patient journey.

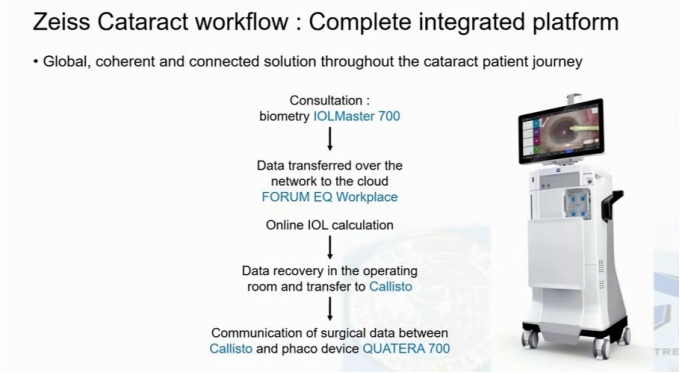
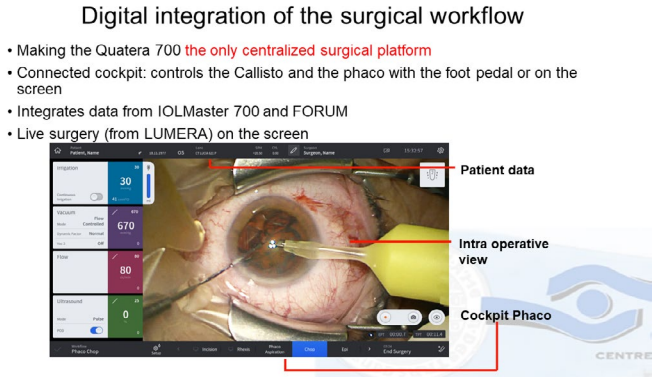


Figure 2: ZEISS QUATERA 700 serves as a surgical cockpit, integrating patient data, displaying the live surgical video, and connecting to ZEISS CALLISTO eye.



ZEISS QUATERA 700 is a next generation, digitally connected phacoemulsification system that serves as a complete surgical cockpit and puts all the information I need during a procedure at my fingertips (Video 2). The phaco machine's screen displays patient data, including patient name, date of birth, and planned IOL. Having convenient visual access to this information eliminates the need for printouts in the OR and therefore avoids situations of having the wrong documents or missing sheets.

ZEISS QUATERA's screen also shows the live video from the surgical microscope, which allows OR staff to follow the progress of the operation in real time and anticipate my need (Figure 2). Thus, my surgical nurse can anticipate my need for a particular instrument or the IOL and have it ready to give to me, saving time.

Through connectivity between ZEISS QUATERA 700 and my microscope's CALLISTO eye, the phacoemulsification parameters are simultaneously displayed on my surgical microscope view. Therefore, I am able to adjust parameters in real time while maintaining my focus through the microscope because I do not have to look away at the ZEISS QUATERA 700 screen.

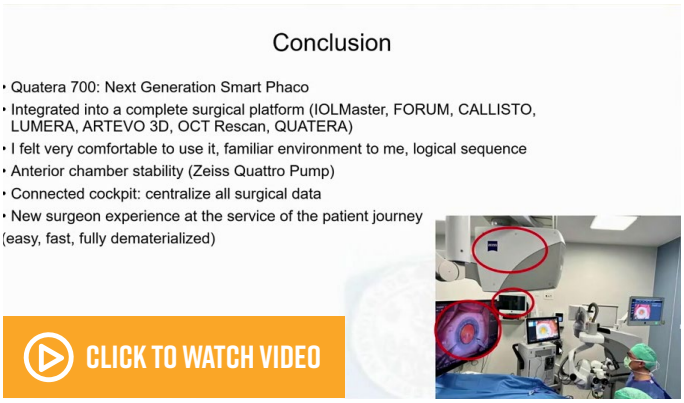
There is also connectivity between ZEISS QUATERA 700 and ZEISS CALLISTO eye that allows me to control CALLISTO eye's assistance functions myself using the phaco device's foot pedal. This connectivity allows me to stay focused on the surgery without having to look at the screen or be talking to and depending on staff.

Conclusion

In my opinion, the digital connection of diagnostic and surgical technologies can optimize patient outcomes and clinic efficiency by streamlining workflow and ensuring data accuracy during cataract surgery. The addition of the ZEISS QUATERA 700 has taken digitalization and efficiency in my clinic to a new level. With the next generation phaco device, I now have a fully connected surgical cockpit that has raised my experience as a surgeon to a new level at the service of the patient journey (Video 3).

Video 2. Case examples

Video 2. Case examples



part 2

Part 2: The digital operating room

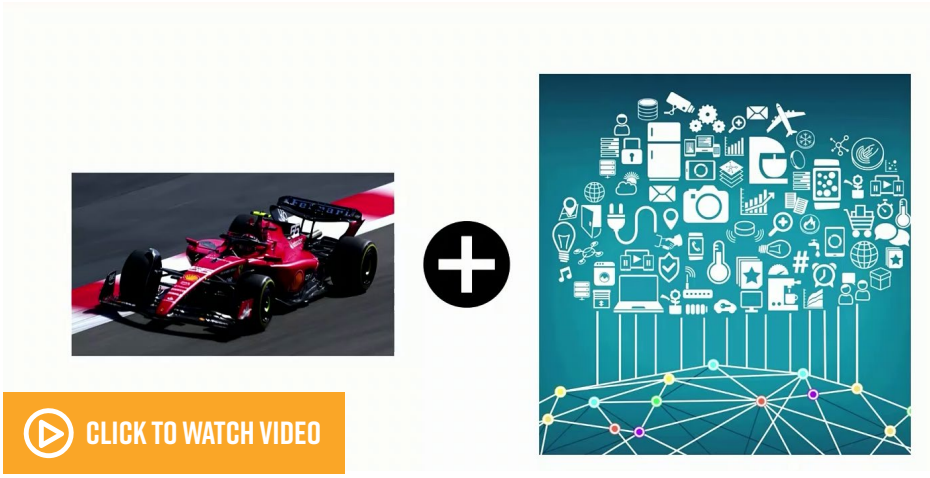
Benefits beyond digitalization

MIGUEL AMARO, MD

CHNO des Quinze-Vingts Paris, France

Operating in a digitally connected environment enables cataract surgeons to achieve the best outcomes and happy patients. However, the technical performance of the tools we use is also a critical factor. Therefore, I appreciate working with ZEISS QUATERA 700 that addresses both needs. In addition to introducing a new world of capability through serving as a surgical cockpit, ZEISS QUATERA 700 is engineered with innovative technology for both fluidics control (QUATTRO Pump®) and ultrasound management (Power on Demand) that I believe have benefit for increasing both surgical safety and efficiency in my clinic (Video 4).

Video 4. Combining latest phaco technology with the opportunities of connectivity and data access

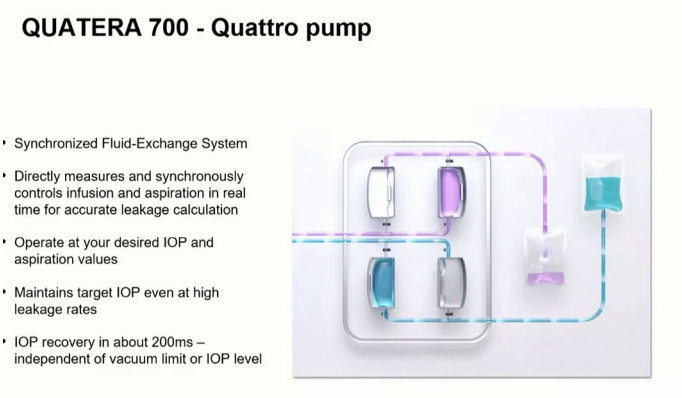


Anterior chamber stability

Although there has been an ongoing evolution in the design of phacoemulsification devices with the aim of optimizing fluidics control during cataract surgery, anterior chamber and IOP instability can still occur. The patented QUATTRO Pump is a unique fluid exchange system designed to address this issue.

The QUATTRO Pump is a synchronized fluid-exchange system that represents a new category of phacoemulsification pumps (Figure 3). It is neither a flow-based (peristaltic) nor a vacuum-based (Venturi) pump, but it brings the best of each of those systems by providing the higher attractability of a Venturi pump and the control of a peristaltic pump. Unlike traditional phaco systems, the QUATTRO pump also directly controls infusion.

Figure 3. The ZEISS patented QUATTRO pump



Video 5. Experiencing attractability, followability, ultrasound modulation and stability in cataract surgery

The new fluidic system consists of two pumps for irrigation and two pumps for aspiration that provide reciprocal exchange of infusion and aspiration fluids (Figure 3). Irrigation and aspiration volumes are directly measured, and the pump system allows accurate calculation of leakage volume so that it provides real-time fluidics compensation and can maintain target IOP, even if leakage is high. Independent of vacuum limit or level of IOP, recovery of target IOP occurs nearly instantly, as low as 200 ms (data collected by Carl Zeiss Meditec).

The performance of the QUATTRO Pump for controlling fluidics was demonstrated in a laboratory study that evaluated management of IOP versus aspiration flow rate and incision leakage rate using a peer-reviewed spring-eye model. Results of this *in vitro* study showed that compared to a competitor's phacoemulsification machine, ZEISS QUATERA 700 was associated with a shorter duration of surge after occlusion break regardless of vacuum and aspiration flow rate settings and thus maintained better chamber stability.[1]

But what does all this mean for our daily work as cataract surgeons? I think all surgeons would agree that maintaining a stable environment is crucial for safe and successful cataract surgery. There are many good phacoemulsification devices available on the market. What is different for me using ZEISS QUATERA 700 is that I feel there is absolute stability, and so for me, concern about surge is a past theme. Therefore, I have the confidence to operate with fairly high flow and high vacuum levels. Consequently, I benefit from high attractability that allows me to operate with efficiency as well as safety. Because the fragments come to the tip, I can keep the phaco tip in the center of the anterior chamber where it is away from the capsule and iris. The attractability and stability provided by operating with ZEISS QUATERA 700 and its QUATTRO Pump can be especially seen in challenging cases, such as in eyes with wider than planned incisions associated with a history of radial keratotomy, fragile zonules, dense cataract or intraocular floppy iris syndrome (Video 5).

Ultrasound management

ZEISS QUATERA 700 has another feature that I believe further supports cataract surgery safety and efficiency, especially for surgeons who are early in their career and still developing their skills, and that is its technology for ultrasound management. Because QUATTRO Pump continuously measures fluid inflow and outflow, it can also detect occlusion and occlusion breaks. The latter capability is the foundation for QUATERA 700's automated ultrasound management system – Power on Demand.

Power on Demand activates ultrasound only when the phaco tip is occluded and switches it off automatically as soon as the occlusion clears. Because activating ultrasound only when it is needed both minimizes total ultrasound energy use and enhances attractability, Power on Demand, in my opinion, represents another opportunity for augmenting cataract surgery safety and efficiency.

Conclusion

I am appreciating the stability and efficiency I am experiencing using ZEISS QUATERA 700 for cataract surgery. In addition, I see that this latest generation phacoemulsification system provides immense value through its digital integration and connectivity with the ZEISS Cataract Workflow that gives "live" control of all parameters and immediate access to biometric and anatomical data

that are essential for case success. With its technologies for fluidics and ultrasound control and capability for enhancing workflow, ZEISS QUATERA 700 is increasing efficiency and safety in the demanding environment of my high volume cataract surgery clinic

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part 3

Part 3: Optimizing outcome precision with leading edge advanced lens technology

The ZEISS AT ELANA 841P – Design details & optical performance testing

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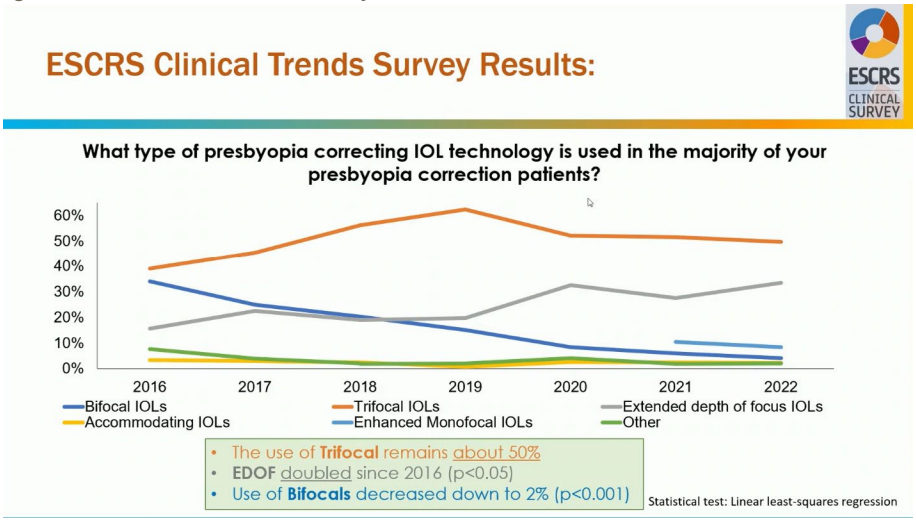
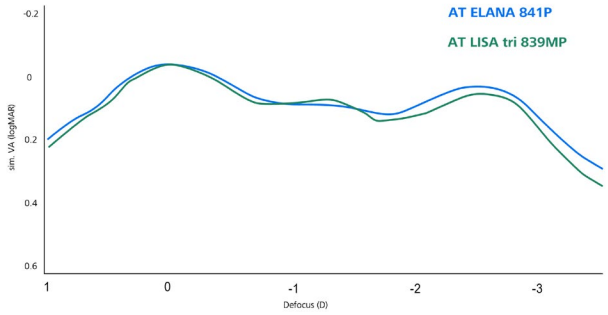
Data collected in the ESCRS Clinical Trends Surveys show that since the polling was first conducted in 2016, the percentage of total cases performed using a presbyopia-correcting IOL has increased significantly.[1] The results also show that throughout the history of the survey, a trifocal IOL was the technology most commonly used for patients wanting presbyopia correction (Figure 1).[1] The latter finding is not surprising considering that compared with other options, trifocal IOLs may be most likely to provide patients good uncorrected vision spanning from far to intermediate to near.[2]

Figure 1. ESCRS Clinical Trends Survey Results 2016 to 2022

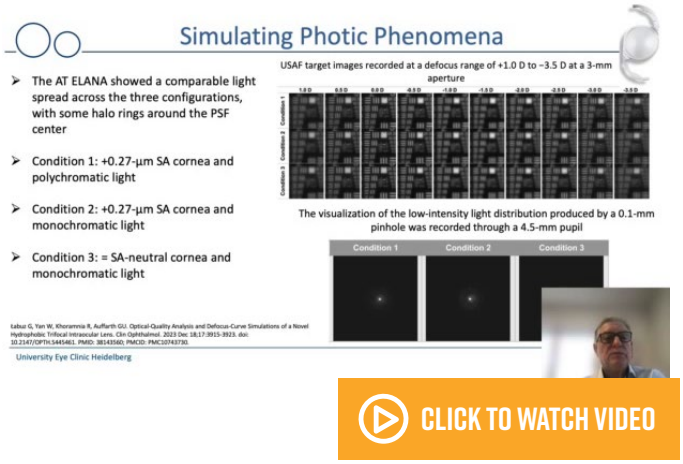


The AT ELANA® 841P from ZEISS is a recent entry into the category of trifocal IOLs. The optic of the ZEISS AT ELANA is based on the optic of the hydrophilic AT LISA® tri 839MP from ZEISS, a trifocal lens with clinical performance proven in over 170 peer-reviewed papers.[3,4] However, the diffractive structure of the ZEISS AT ELANA differs in a few ways. First, its increased overall light transmission efficiency due to an improved diffractive structure and a higher proportion of light allocated towards near vision, lead to an enhanced near-to-intermediate vision without compromising distance vision*. The ZEISS AT ELANA optic also stays fully trifocal over its entire optical zone. In addition, the aspheric optic of the AT ELANA is aberration-neutral whereas the AT LISA tri 839MP aspheric optic is an aberration-correcting design.

Figure 2. Defocus curve with AT ELANA and AT LISA tri; simulated visual acuity based on optical bench MTF measurements; pupil size 3 mm; aberration-neutral cornea mode



Video 1. In vitro evaluation of photopic phenomena and glistening of AT ELANA 841



For its haptic platform, the ZEISS AT ELANA uses the same rigid optic-haptic junction and step-vaulted C-loop haptics as the CT LUCIA® 621P from ZEISS, which are features that enable centration and maximize capsular contact to provide positional stability and resistance to posterior capsule opacification (PCO).[5,6] In addition, the AT ELANA is made of the same biomaterial as the CT LUCIA 621P, which is a glistening-free** hydrophobic acrylic with a heparin-coated*** surface that allows smooth and controlled unfolding. The material also delivers good clarity.

We conducted a series of *in vitro* evaluations to assess the optical performance of the ZEISS AT ELANA and to compare it with the ZEISS AT LISA tri 839MP.[2,7] First, we found that visual acuity (VA) values and defocus curves simulated from bench testing measurements of modulation transfer function (MTF) indicated that the AT ELANA is capable of delivering 0.1 logMAR or better VA at far, intermediate, and near distances.

Whether looking at the simulated VA or MTF results, the performance of the AT ELANA over an extended range of defocus was generally similar to that of the AT LISA tri 839MP, although the AT ELANA was slightly superior at near (Figure 2). Analyses of MTF data also showed that the optical performance of the AT ELANA was more resistant to decentration than the AT LISA tri 839MP, which can be attributed to the aberration-neutral aspheric design of the AT ELANA. MTF values for the AT ELANA remained stable over the tested decentration range of up to 1.0 mm.

In addition, we found that like the AT LISA tri 839MP, the AT ELANA has excellent pupil independent light utilization. Therefore, the AT ELANA might be expected to have the same profile of photic phenomena as the AT LISA tri 839MP (Video 1).

part 3

Part 3: Optimizing outcome precision with leading edge advanced lens technology

ZEISS AT ELANA clinical outcomes

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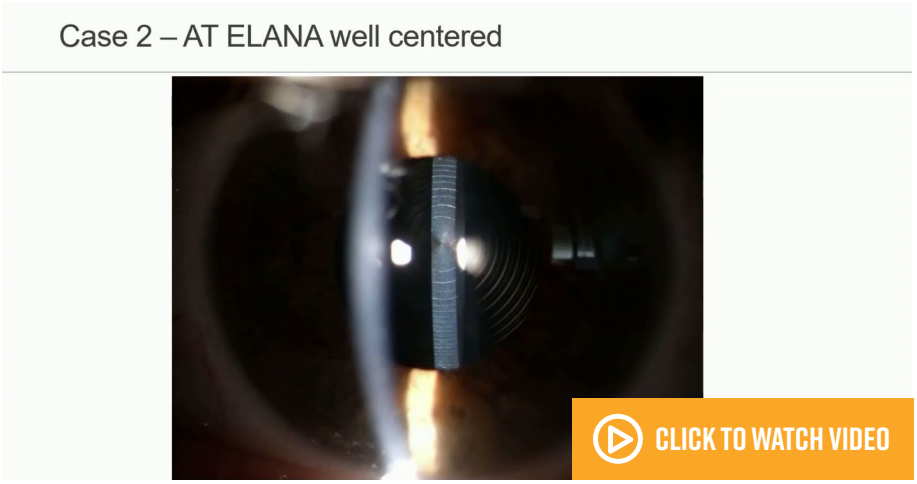
Department of Ophthalmology, Third Faculty of Medicine Charles University, Prague, Czech Republic.

I began implanting the ZEISS AT ELANA as an investigator in a clinical trial. Findings from follow-up visits at 1 day, 3 months, and 5 months after surgery from the second patient enrolled in this study show the optical quality of the AT ELANA, its stability, and its potential to provide a full range of good uncorrected vision (Video 2).

Video 2. Outcome analysis for one patient case with ZEISS AT ELANA



Results from analysis of data collected in 10 patients who had bilateral implantation of the ZEISS AT ELANA demonstrate refractive predictability and excellent visual outcomes. We analyzed data from the first 10 patients who underwent bilateral implantation of the AT ELANA. IOL power was calculated with the ZEISS IOLMaster 700 using the Haigis and SRK/T formula for eyes with short axial length and the Hoffer Q or Barrett TK Universal formula for longer eyes. Mean implanted IOL power was 23.1±2.13 D (median 23.0 D; range 19.5 to 27.5 D).

At 1 month, the achieved refractive predictability was very high with 85% of the patients within ±0.5 D of target refraction and 100% within ±1.0 D. These results are impressive and far exceed criteria found in the Royal College of Ophthalmologists Cataract Surgery Guidelines that set benchmark standards for rates of achieved refraction of 55% for outcomes within ±0.5 D of target and 85% for eyes within ±1.0 D.

Table 1. Visual acuity (logMAR) and refractive outcomes 1 month after implantation of the ZEISS AT ELANA IOL

Parameter	Monocular		Binocular	
	1-Month-Follow-Up		1-Month-Follow-Up	
logMAR	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)
CDVA	-0.09 (0.13)	-0.10 (-0.60 to 0.12)	-0.11 (0.06)	-0.10 (-0.20 to -0.02)
UDVA	-0.01 (0.10)	-0.04 (-0.12 to 0.26)	-0.08 (0.06)	-0.09 (-0.16 to 0.00)
UIVA	0.08 (0.07)	0.09 (-0.06 to 0.24)	0.00 (0.07)	0.00 (-0.12 to 0.12)
DCIVA	0.09 (0.06)	0.09 (0.00 to 0.20)	0.04 (0.07)	0.03 (-0.08 to 0.18)
UNVA	0.13 (0.09)	0.14 (-0.08 to 0.28)	0.07 (0.05)	0.08 (-0.02 to 0.12)
DCNVA	0.10 (0.08)	0.08 (-0.02 to 0.30)	0.01 (0.07)	0.02 (-0.10 to 0.10)
SEQ (D)	-0.02 (0.31)	0 (-0.5 to +0.5)	n/a	n/a

Abbreviations: SD, standard deviation; CDVA, corrected distance visual acuity; UDVA, uncorrected distance visual acuity; UIVA, uncorrected intermediate visual acuity; DCIVA, distance-corrected intermediate visual acuity; UNVA, uncorrected near visual acuity; DCNVA, distance-corrected near visual acuity; SEQ, spherical equivalent of autorefraction; D, diopter; na, not applicable)

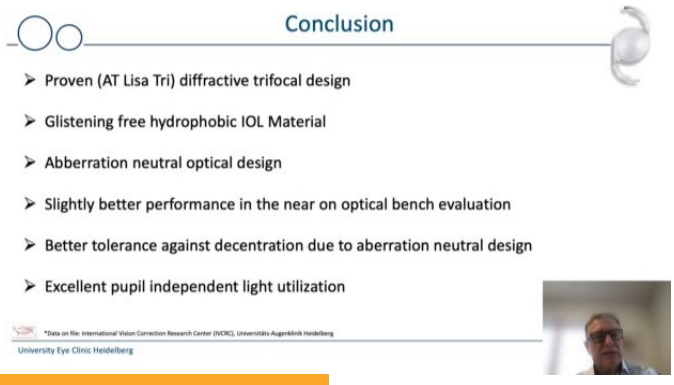
Monocular and binocular VA results for the 10 patients were consistent with the excellent refractive outcomes (Table 1). In all patients, uncorrected logMAR VA was 0.1 or better at distance (ETDRS 4 m), intermediate (80 cm), and near (40 cm).

Even more importantly, and as expected, the excellent refractive and functional results corresponded with a high level of patient satisfaction with their vision and improved visual function. We are seeking to formally validate the benefits of the ZEISS AT ELANA for enabling spectacle independence by having patients complete the Catquest-9SF questionnaire preoperatively and one month after their second eye surgery. This validated instrument includes two general questions about difficulty and satisfaction with sight and seven questions about difficulty with specific daily life activities. Data from our first 10 patients clearly show their satisfaction with and benefit gained from surgery with the trifocal AT ELANA (Figure 3).

Conclusion

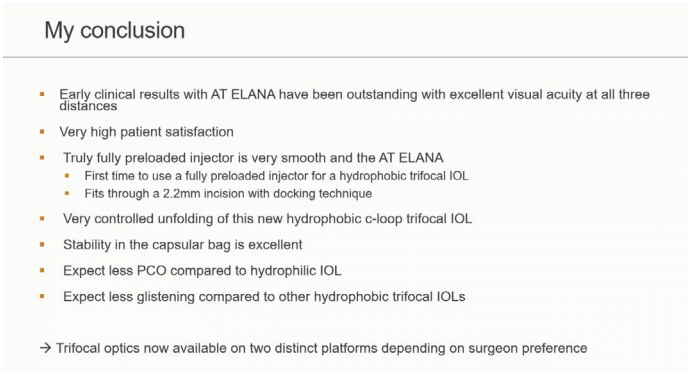
Findings from optical bench tests evaluating the ZEISS AT ELANA (Video 3) and clinical experience are positive and support its potential to provide patients with an extended range of good uncorrected vision. (Video 4). In addition, implantation of the fully preloaded AT ELANA IOL is easy and controlled, and this IOL is demonstrating excellent postoperative stability, refractive predictability, and functional outcomes. Furthermore, comments received during follow-up visits along with subjective questionnaire results show a very high level of patient satisfaction.

Video 3. Findings from optical bench tests evaluating the ZEISS AT ELANA



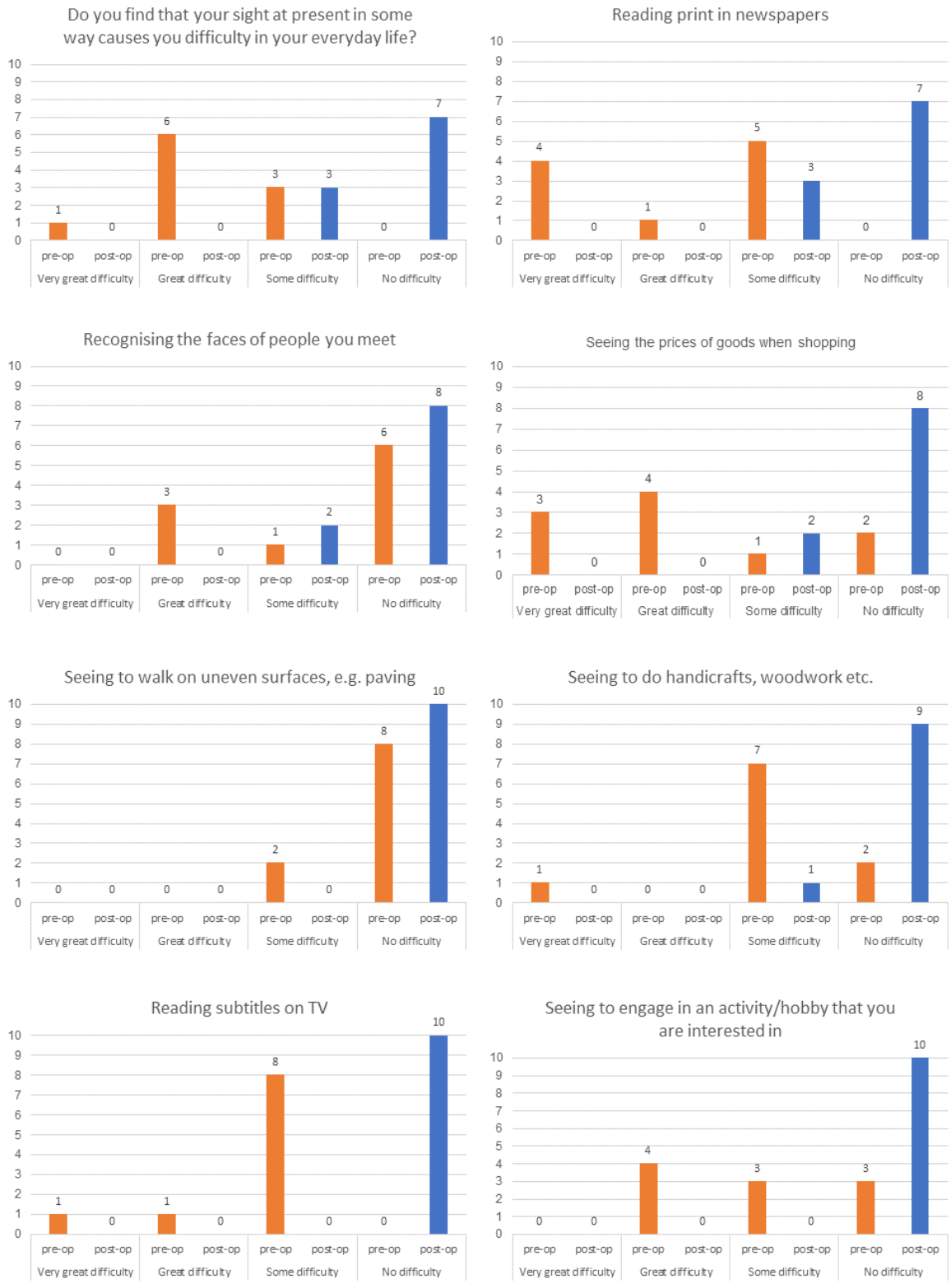
CLICK TO WATCH VIDEO

Video 4. Findings from clinical experience are positive and support its potential to provide patients with an extended range of good uncorrected vision



CLICK TO WATCH VIDEO

Figure 3. Patient satisfaction before and after surgery (Catquest 9SF Questionnaire)



With the introduction of the AT ELANA 841P, outstanding trifocal IOL technology from ZEISS is available on two distinct platforms. Therefore, regardless of their personal preference for lens biomaterial or haptic design, all cataract surgeons now have the opportunity to satisfy their patients seeking presbyopia correction with clinically proven technology.

* Compared to ZEISS LISA tri in photopic conditions in virtual implantations and optical bench test results

** Grade 1 (traces) or better for 85% of the patients up to and including 12 months according to Christiansen scale and based on internal clinical trial outcomes and on published clinical data.

*** Fragment of heparin used in IOL surface coating with no pharmacological, immunological or metabolic action.

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part 4

Part 4: Improving surgical performance with an AI-based application

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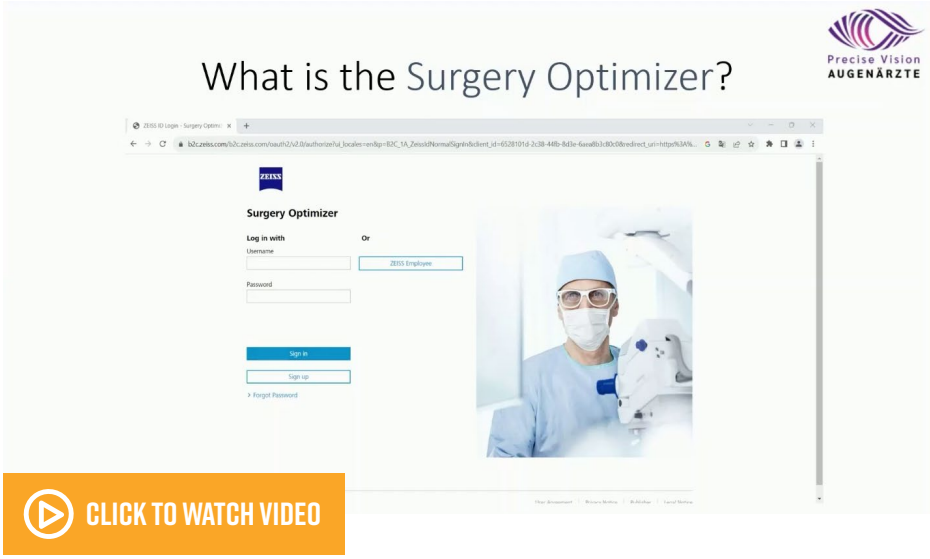
In 2022, having completed my residency, I began working as a specialist at the Eye Day Clinic in Rheine, Germany. Like other young ophthalmologists beginning a career in cataract surgery, I wanted to further improve my surgical skills to be able to provide my patients with the best possible outcomes. I felt fortunate that Dr. Florian Kretz, the clinic's medical director, was my mentor as I continued my surgical training. In addition, I quickly found benefit from using the new ZEISS Surgery Optimizer.

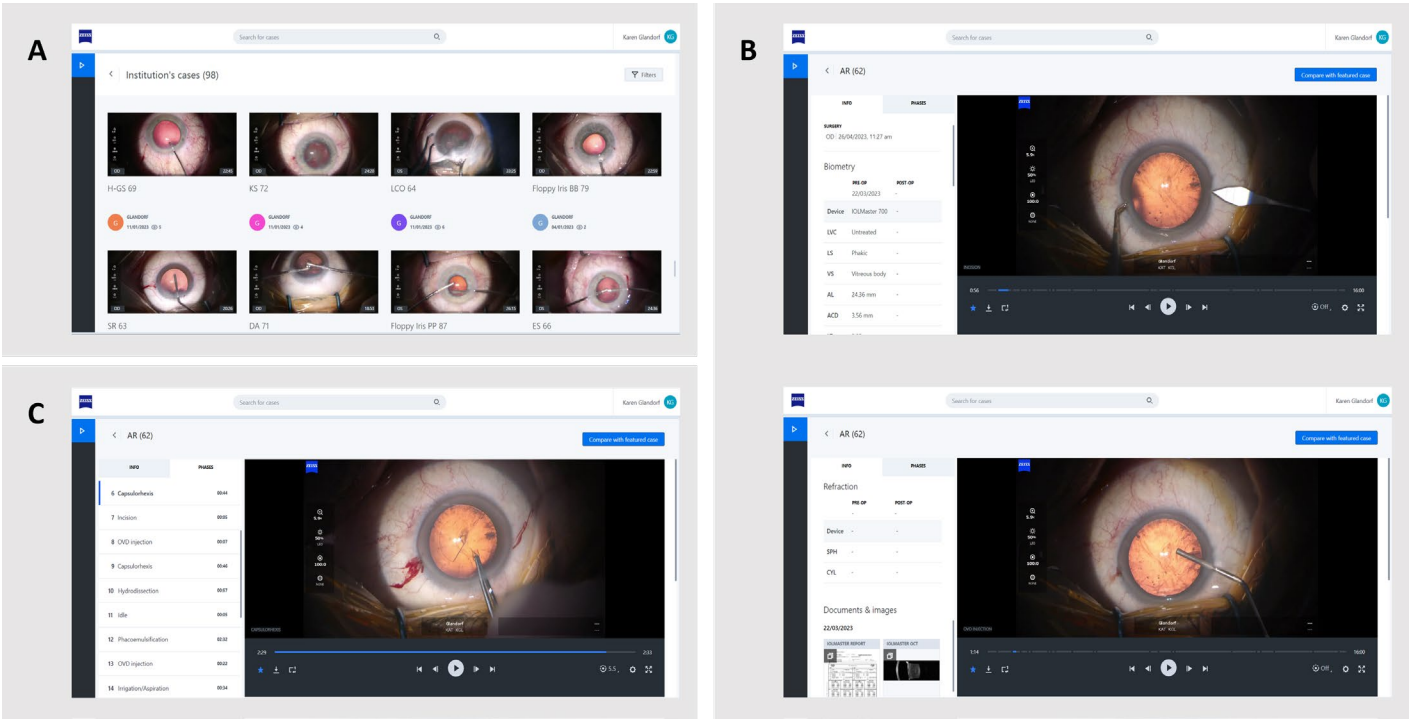
Video 1. ZEISS Surgery Optimizer – What it is and how to use it?



ZEISS Surgery Optimizer is an innovative artificial intelligence (AI) and cloud-based application that takes both the opportunity for self-learning from surgical video review and the experience to a whole new level.

Watching intraoperative recordings of one's own cataract surgeries and of those performed by more experienced colleagues is a well-recognized method by which surgeons can identify ways to refine their skills, improve surgical efficiency, and reduce risk of complications. Its use, however, may be limited by the complexity and time-consuming tasks of exporting and accessing the materials. The ZEISS Surgery Optimizer revolutionizes the entire process by providing surgeons easy access to surgical videos on their personal devices without having to manually export and import the files. Once a case is completed,

Figure 1. With ZEISS Surgery Optimizer you have access to all your surgery videos uploaded from the ZEISS CALLISTO eye (A). The application displays the recording of your surgery along with patient data (B). By clicking on "Phases", surgeons can select and watch the clip of a specific surgical step (C).



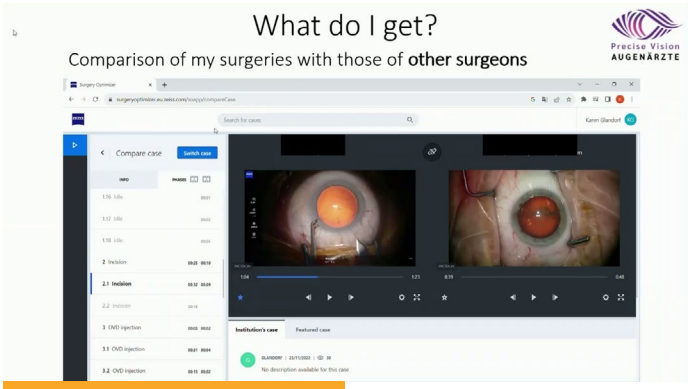
surgeons simply have to click a button to import the recording from ZEISS CALLISTO eye to a cloud-based software system. Personal surgical videos along with those uploaded and authorized for sharing by other cataract surgeons are then immediately available for viewing on a computer via a web browser or on a mobile device using the ZEISS Surgery Optimizer (Video 1).

While using ZEISS Surgery Optimizer, surgeons have all their case videos at their fingertips (Figure 1A). The screen displays the video along with patient data, including date of surgery, biometry data from ZEISS IOLMaster, surgery details from ZEISS CALLISTO eye and data, images, and documents from other diagnostic devices (Figure 1B). Using AI, ZEISS Surgery Optimizer segments the recorded case into phases (i.e. incision, OVD injection, capsulorhexis, hydrodissection, phacoemulsification, irrigation/aspiration, IOL implantation, etc.) that can be individually selected for review (Figure 1C). Clear case documentation details and easy database creation allow surgeons to readily search for cases based on specific features. In addition, with ZEISS Surgery Optimizer, surgeons can watch two videos side-by-side in split-screen view and thereby compare their technique during two of their own cases or between a case from their own library and one available from another user.

Personal reflections - What I gained from ZEISS Surgery Optimizer

I cannot underscore enough how much I appreciate the easy and convenient access I have to my surgical videos using ZEISS Surgery Optimizer. In addition, the phase segmentation feature that allows me to concentrate on and compare my technique when performing specific surgical steps enhances my ability to learn from video review and makes learning more efficient. By using the phase selection feature and split-screen view to compare my technique with that of a more experienced surgeon helps me identify ways to refine my technique and improve my skills so that my surgery becomes more precise and more efficient (Video 2). Then using the same features to compare my performance on two of my own cases allows me to assess how I am doing on my learning curve.

Video 2. What I gained from ZEISS Surgery Optimizer - Comparing your own surgery performance with the performance of advanced surgeons



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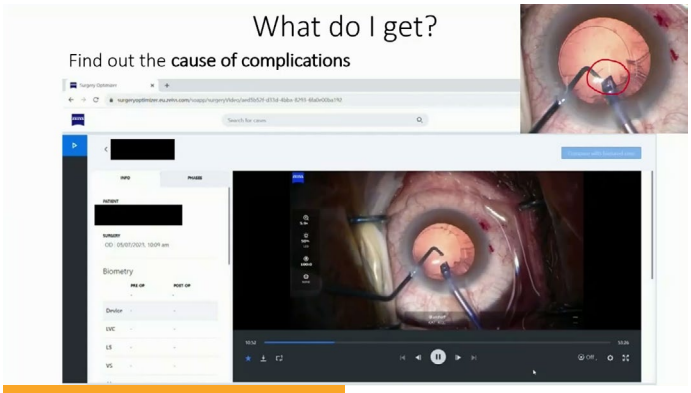
Video 3. What I gained from ZEISS Surgery Optimizer - Learning from complications



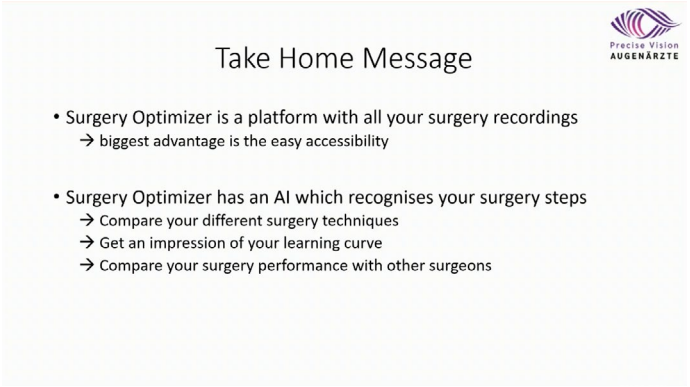
CLICK TO WATCH VIDEO

The recordings of complicated surgeries are of the greatest importance to me (Video 3). Being able to watch the video at the end of the day with my mentor when the case was fresh in my mind helped me understand what led to the complication and use what I learned to avoid it in the future.

Conclusion

I am now just a few years into my career as a practicing ophthalmologist, and I still consider myself a beginner when it comes to cataract surgery. However, I can say definitively that thanks to its many features and advantages, ZEISS Surgery Optimizer is an outstanding teaching tool and has helped me to improve my cataract surgery skills (Figure 2). Going forward, I am continuing to take advantage of this excellent tool as I strive towards optimizing my outcomes for the benefit of my patients.

Figure 2. The benefits of using an AI-based application for reviewing surgical videos



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