

Introducing the Forefront Technologies in Refractive and Cataract Surgery

Supplement to EyeWorld Asia-Pacific September 2024

A Zeiss dinner symposium was held on Wednesday May 29, 2024 before the official start of the APACRS 2024 Chengdu in which five renowned surgeons of the Asia Pacific region shared their insight on the newest innovations in refractive and cataract surgery.

“Here, we will discuss cutting-edge technologies,” moderator Naren Shetty MBBS, MS (Ophth) (India) said, “and Zeiss has always been the pioneer and leader in refractive and cataract surgery.”

What is Coming Next for Hyperopic SMILE?

Sri Ganesh MBBS, DNB, DSC(Hon), FRCS, FWCRC (India)

“Hyperopic small incision lenticule extraction (SMILE) is something we have been waiting on for a long time,” Dr. Ganesh said as he began his presentation. “Zeiss is a leader in lenticule extraction, so we can expect nothing less from this technology.” Dr. Ganesh remarked that hyperopic SMILE has always been a debate - that it is not possible to treat hyperopia with lenticule extraction - but Zeiss is now introducing this technology so that surgeons can treat myopia, myopic astigmatism, hyperopia, and hyperopic astigmatism.

Sekundo et al (2016)¹ conducted the first study on nine hyperopic eyes using the 500 kHz femtosecond laser and the femtosecond lenticule extraction (ReLEx FLEx) technique. In this prospective study, the results were acceptable with 70% of eyes having a refractive predictability of ± 0.5 D and 89% of eyes within 1.0 D. Further studies were conducted,^{2,3,4} and surgeons were able to achieve very good centration using a 6.3 mm to 6.7 mm optical zone. “A 6.3 mm optical zone with SMILE corresponds to a 7 mm optical zone with laser-assisted in situ keratomileusis (LASIK), so you effectively get a larger optical zone, and the advantage is lower spherical aberration,” Dr. Ganesh said.

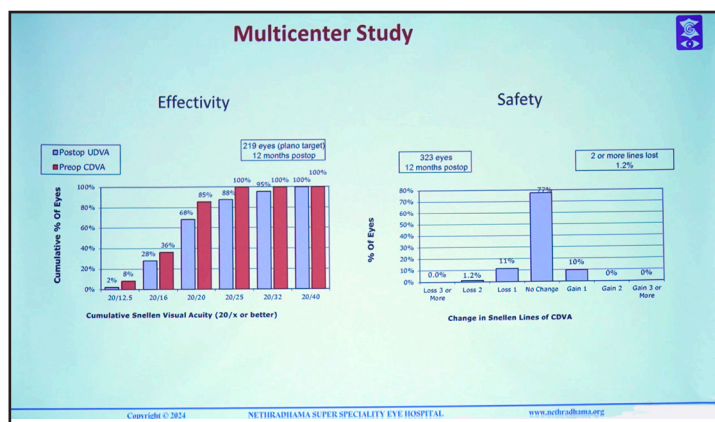
In a multicenter study that has been completed and submitted for publication, patients from eight different medical centers (countries included Germany, China, United Kingdom, India, Czech Republic, and France) with hyperopia or hyperopia with astigmatism and a predicted postoperative keratometry of ≤ 51 D underwent lenticule extraction. Dr. Ganesh’s medical center, Nethradama Super Specialty Eye Hospital in Jayanagar, India, participated in this study, and the results were promising.

Over a 12-month follow-up period, patients showed an improvement in the safety index and contrast sensitivity remained within the normal range, although there was a slight drop from preoperative values. Regarding efficacy, 88% of postoperative eyes were 20/25 or better, and 68% of eyes were 20/20 or better. Additionally, 77% of eyes showed no change in Snellen lines of corrected distance visual acuity (CDVA), 10% of eyes gained one line, and two or more lines were lost in 1.2% of eyes.

At the 12-month mark, 81% of eyes were within 0.5 D and 93% of eyes were within 1.0 D. Some amount of regression could be seen after 9 months: 9% of eyes changed more than 0.5 D between 9- to 12-month follow-up, which Dr. Ganesh attributed to late epithelial healing. However, astigmatic values over 1.0 D were well-corrected: seventy-five percent of eyes were ≤ 0.5 D and 93% of eyes were ≤ 1.0 D after surgery.

Dr. Ganesh concluded that these results fared much better than previous hyperopic FLEx and SMILE studies, showing marginally better refractive outcomes with slightly less regression.

In a patient case video, Dr. Ganesh provided some tips when using the VisuMax[®] 500 for the laser cut. “My technique is to dissect more in the periphery. In hyperopic patients, you should be careful with dissecting in the center. That is where



From Dr. Ganesh’s multicenter study, 88% of eyes showed 20/25 or better and 68% of eyes showed 20/20 or better visual acuity. In terms of safety, 77% of eyes showed no change in Snellen lines of CDVA.

the lenticule is the thinnest and you can actually perforate it if you are not careful. This case is the opposite of myopic patients in which the lenticule is the thickest in the center,” he said.

“Integration of hyperopic SMILE with the new VisuMax[®] 800 should be available any day now and will provide a new excellent option for laser vision correction (LVC) of hyperopia and hyperopic astigmatism,” Dr. Ganesh said. “With the VisuMax[®] 800, we can expect a lot less suction loss, faster surgery times, and tracking for centration and cyclotorsion.”

Clinical Experience and Patient Results of SMILE Pro

Tang Seng Fai, MD (Malaysia)

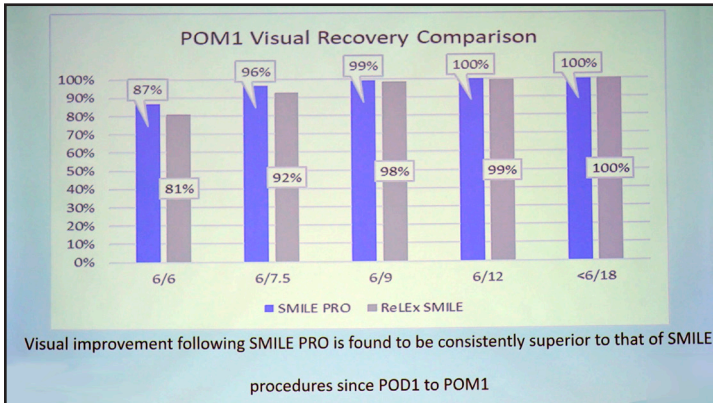
For Tang Seng Fai, MD (Malaysia), SMILE Pro has been a new toy since October 2023 at his eye care center, Optimax Eye Specialist, the only SMILE Pro provider in Malaysia. The transition period since October, Dr. Fai describes, has involved upgrading patients from SMILE to SMILE Pro and adapting to the surgeon experience.

From October 2023 to April 2024, Dr. Fai was able to collect data on patients who underwent SMILE Pro procedures and ReLEx SMILE surgery. In his comparison, Dr. Fai looked at 1,197 eyes that underwent SMILE Pro and 1,156 eyes that underwent ReLEx SMILE. What he found was that SMILE Pro resulted in better outcomes for patients at postoperative day 1, week 1, and month 1.

“Visual improvement following SMILE Pro was consistently superior to that of ReLEx SMILE,” he said, “with higher treatment accuracy for both spherical and cylindrical power.” In terms of refractive outcomes, SMILE Pro yielded a treatment time of less than 10 seconds, which means less chance for eye movement. Furthermore, greater treatment centration with SMILE Pro means better visual outcomes.

Because no suction loss occurred during either surgical procedure, SMILE Pro or ReLEx SMILE, the surgery complication rate remained insignificant in both groups.

Surgeons from Dr. Fai’s center provided feedback on their experience with performing SMILE Pro. Many reported experiencing no more suction loss in addition to less fear of suction loss. Some commented on better ergonomics and better patient comfort due to an extremely fast laser time. Finally, one surgeon said,



Data collected by Dr. Tang showed that patients experienced better visual improvement from postoperative day 1 to month 1 following SMILE PRO procedures compared to SMILE.

“the astigmatism axis adjustment gives more accurate and more reliable results, making me more comfortable with high astigmatism cases.” Overall, feedback on SMILE Pro was positive, allowing surgeons the comfort and ease in performing their cases.

Achieving Excellent Patient Outcomes with the Refractive Workplace® and VISULYZE®

Lin Pi-Jung, MD, EMBA, PhD (Taiwan)

Lin Pi-Jung, MD, EMBA, PhD (Taiwan) states that about 78% of surgeries at his eye center consist of SMILE Pro procedures. As the founder of Universal Eye Center in Taipei, Taiwan, the first ophthalmology clinic in Taipei, Dr. Lin has been performing laser refractive surgery since 1997. The center currently owns ten VisuMax 500 and eight VisuMax® 800 devices, has completed more than 50,000 surgeries, and currently treats about 30-50 patients a day. SMILE and SMILE Pro procedures account for 80-90% of all procedures done at the eye center.

“Since the end of 2019 when we first introduced the VisuMax, we have received excellent feedback from our patients on efficacy and safety,” Dr. Lin said. However, upgrading to the VisuMax® 800 and Refractive Workplace® allowed Dr. Lin and his colleagues to experience many more advantages in laser refractive surgery. In addition, all images and data upload to the FORUM® system, making it easy for the surgeons and patients to communicate as well as reduce human input error.

Opportunities for human input error come from all stages of surgery. Before surgery occurs, errors may come up during the examination, transcription, or astigmatism planning phase. During surgery, surgeons may encounter cyclotorsion or positioning error. With the VisuMax® 800 linked to the IOLMaster® 700 and FORUM®, surgeons are able to minimize these errors as well as assess patients’ conditions well before entering the operating room. “The process is much smoother and optimized for efficiency,” Dr. Lin said. “We no longer have to re-enter data. The number of surgeries performed has increased from four patients per hour to eight patients per hour.”

From data that Dr. Lin collected at his eye center, he found that surgeons saved 25.3% (75.5 seconds savings) of their time during operation by eliminating the need to input patient data when using the VisuMax® 800 and the Refractive Workplace® compared to using only the VisuMax® 800. Docking, lasering, and lenticule extraction were much quicker using this combination setup. Further, there was a 39.5% decrease in time (145.5 seconds savings) during operation compared to using only the VisuMax® 500. In terms of the total process (planning

and operation), surgeons can save up to 175.15 seconds by using the VisuMax® 800 (compared to using the VisuMax® 800 without the Refractive Workplace®) or 250.9 seconds (compared to using only the VisuMax® 500).

“I prefer performing SMILE Pro because of the short laser time and not having to manually enter data,” Dr. Lin said. In 2023, he studied clinical outcomes at his eye center, comparing 3,430 eyes using SMILE Pro to 1,316 eyes using SMILE (total 4,746 eyes). Patients were followed up on day 1, week 1, month 1, and month 3 after surgery and analyzed using the VISULYZE® software. The results showed that 97.8% of patients were within 1 D using the VisuMax® 800 and 97.1% of patients were within 1 D using the VisuMax® 500. “Both systems have good clinical outcomes, though the VisuMax® 800 offered better stability, more precise astigmatism correction, and a shorter treatment time,” Dr. Lin said. Overall, Dr. Lin concluded by stating that his surgeries with the VisuMax® 800 have provided a great increase in surgical efficiency and an improved physician quality of life.

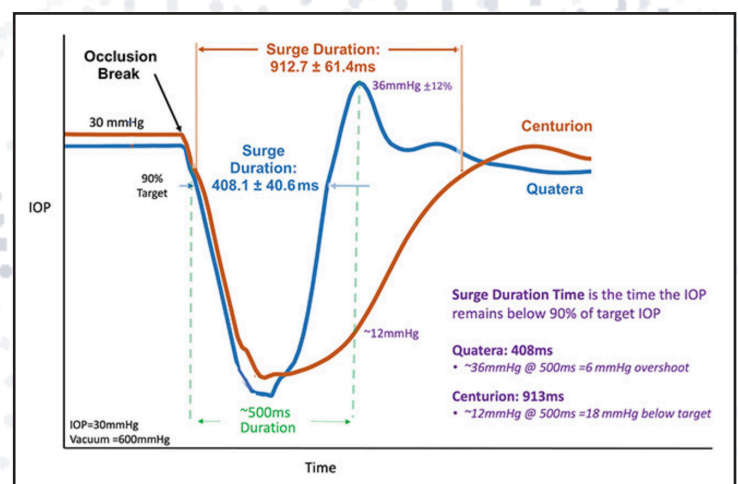
Unleashing the QUATTRO Pump® in Action

Ishtiaque Anwar, MBBS, FCPS, DO (Bangladesh)

“Our aim for cataract surgery,” Ishtiaque Anwar, MBBS, FCPS, DO (Bangladesh) said, “is not only to remove the cataract, but to cause less harm to the eye and maintain the stability of the anterior chamber.” There are a number of parameters that surgeons are able to control: flow rate, vacuum, power, and intraocular pressure (IOP). In addition, ultrasonic effects from the surgical procedure can cause damage to various parts of the eye and may result in cavitation, vibratory disruption, mechanical trauma, or free radical injury.

“To avoid these ultrasonic effects,” Dr. Anwar said, “we look for ways to reduce power. Another way is to increase the flow rate and vacuum, but it does affect chamber stability.” Conventional methods to prevent surge and remove fluid in cases like these use the peristaltic pump or venturi pump. However, these may not be the best option; for example, peristaltic pumps build vacuum only after occlusion, and flow rate and vacuum act independently from each other.

The QUATTRO Pump®, though, provides a method to stabilize the chamber independent of IOP and flow as it is a synchronized fluid-exchange system. It consists of 10 valve plungers, an irrigation pressure sensor, 4 spring-loaded pneumatic ports to control irrigation and aspiration volume, and 4 inductive sensors to measure irrigation and aspiration flow. Two pumps are used for air suction and air pushing. With the QUATTRO Pump®, the system directly measures and synchronously controls infusion and aspiration in real time.



Occlusion Break Response: Quatera exhibited a quicker recovery.

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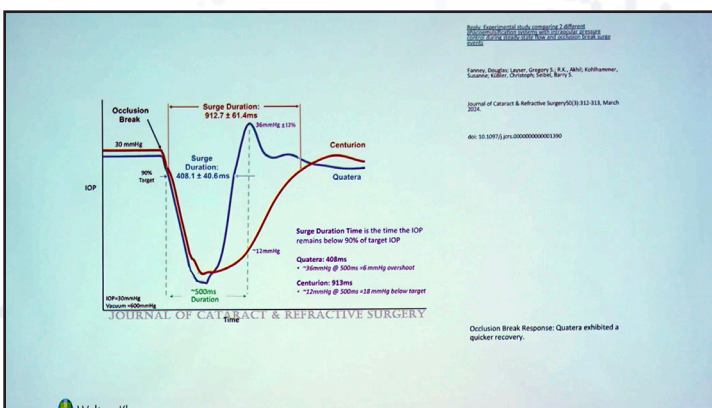
Dr. Anwar stated that IOP recovery can occur in about 200 ms while still being independent of the vacuum limit or IOP level. Additionally, the pump provides active incisional leakage compensation, meaning there is real-time pumping of fluid to make up for any leakage volume.

In a 2023 paper by Fanney et al,⁵ Dr. Anwar discussed the results which showed that the QUATTRO Pump[®] demonstrated higher surge peak values and shorter surge duration times as compared to the Centurion[®] system. The time the IOP remained below 90% of the target IOP was 408.1 ms for the QUATTRO Pump[®] and 913 ms for the Centurion[®] pump.

Dr. Anwar also emphasized the feature of “Power on Demand,” saying that the QUATTRO Pump[®] can use up to 50% less ultrasound upon occlusion, and there is no need to constantly press and release the foot control pedal to modulate the ultrasound. “This provides a much more relaxed surgical experience,” he stressed.

In his own study, Dr. Anwar compared 50 eyes using the QUATERA[®] 700 with high parameters (aspiration flow rate 70-90 cc/min, vacuum 500-700 mmHg, and IOP 30-60 mmHg) and 50 eyes using Centurion[®] with low parameters (aspiration flow rate 25-30 cc/min, vacuum 250-400 mmHg, and IOP 20-50 mmHg). He found that the total phacoemulsification time was faster with the QUATERA[®] 700 than the Centurion[®]. Although macular thickness and endothelium cell count six weeks after surgery was not statistically significantly different in either group, the effective emulsification time was significant for the QUATERA[®] 700 (24 seconds vs. 37 seconds).

“What I feel is that it is not just finishing a surgery; it’s a journey,” Dr. Anwar remarked. “A good surgery is not enough for the patients now.” He explained that many patients may not understand the concept of IOP, but his myopic patients are aware. “These patients,” he said, “can feel the high IOP. If you are able to reduce IOP for them, it really makes them feel comfortable.”



Fanney et al (2023)⁵ showed that the mean surge duration, the time the IOP remained below 90% of target IOP, for the Quattro Pump[®] was 408.1 ms and while the Centurion[®] pump had a surge duration time of 913 ms.

The Importance of Total Keratometry in IOL Calculations

Yeo Tun Kuan, FRCOphth, FAMS (Singapore)

“We know that standard keratometry (K) estimates corneal power by measuring the anterior corneal radius,” Yeo Tun Kuan, FRCOphth, FAMS (Singapore) stated. However, Total Keratometry (TK) combines anterior corneal power with posterior corneal power and central corneal thickness measured by swept source optical coherence tomography (OCT).

“Total Keratometry values can be used for the Barrett and EVO formulas,” Dr. Yeo explained. “However, because they are thick lens IOL formulas, you should not use TK directly in place of K. Instead, the correct way would be to input K and posterior corneal power (PK) as separate parameters.”

When using the Barrett formulas on the IOLMaster[®] 700 with TK, it is actually utilizing standard K and PK as separate inputs. Similarly, on the online Barrett calculators, to utilize measured posterior cornea, one must select “measured PCA” to input PK values and indicate that the values are from IOLMaster[®] 700.

The most important question is of course: Is Total Keratometry beneficial and does it help to provide more accurate outcomes? In some of the earliest publications on this topic, studies found that there was a trend towards a lower mean absolute error for TK compared to K, and there was a slightly higher proportion of eyes within ± 0.25 , 0.50, and 1.00 D.^{6,7} However, Dr. Yeo also discussed how some recent studies found lower refractive prediction accuracy when using TK instead of K and that TK was not superior compared to K with comparable prediction outcomes.^{8,9}

“This is to be expected,” Dr. Yeo explained. “Since TK was designed to be very similar to K, you should not expect any significant advantages of TK over K in normal eyes,” he stressed. So when is TK beneficial? “In eyes with atypical corneas,” Dr. Yeo said. “TK has been proven to be very useful in post-refractive surgery eyes.”

A 2020 study¹⁰ found that the Barrett True-K TK provided the lowest mean refractive prediction error (RPE) and variance for patients with either prior myopic or hyperopic laser vision correction (LVC). The latest study¹¹ in 2024 on eyes with prior myopic LVC showed that the EVO 2.0 PK, Barrett True-K TK and PEARL-DGS formulas performed the best, achieving better results than the Hoffer QST and legacy formulas such as Haigis-L and Shammas-PL.

“You can see the trend that using TK or PK values provide better outcomes in eyes with previous myopic LVC,” Dr. Yeo said. “The top formulas were the ones that used total keratometry or posterior cornea measurements from the IOLMaster[®] 700.”

Dr. Yeo then explained his multicenter study involving the Singapore National Eye Center and Tan Tock Seng Hospital comparing the accuracy of existing and new post-myopic LVC formulas. There were 900 eyes with standard keratometry values and 517 eyes with TK and PK values. With standard keratometry, the accuracy of the top performing formula was 62.0% within 0.5D. “But, if you use total keratometry, the accuracy increases to 66.5%. Overall, the TK/PK formulas perform better,” Dr. Yeo said.

“Looking at axial length bias, the EVO PK and Barrett True-K PK formulas did not have any error bias against axial length and performed well for fairly short to very long eyes.” If one looks at the other formulas, though, there is significantly greater axial length bias.

Results: Total Keratometry (n = 517)

	Mean Error	Std Dev	MAE	MedAE	<=0.25	<=0.50	<=0.75	<=1.00	RMSE
EVO PK	-0.057	0.574	0.425	0.311	42.36%	66.54%	82.40%	90.72%	0.577
EVO	-0.059	0.592	0.447	0.336	41.20%	64.22%	80.85%	89.17%	0.594
Barrett True-K PK	-0.150	0.597	0.463	0.345	39.07%	64.60%	80.08%	88.20%	0.615
PEARL-DGS TK	0.081	0.618	0.468	0.347	38.49%	63.64%	79.88%	89.75%	0.623
Shammas-Cooke	-0.042	0.629	0.476	0.372	37.72%	63.25%	78.92%	87.04%	0.629
PEARL-DGS	-0.031	0.633	0.481	0.368	34.62%	62.28%	78.72%	88.59%	0.633
Barrett True-K	-0.207	0.609	0.496	0.395	34.62%	61.12%	78.14%	86.65%	0.643
Haigis TK	0.156	0.643	0.496	0.373	34.04%	62.48%	79.30%	86.85%	0.661
ASCRS Ave	-0.369	0.619	0.579	0.486	26.69%	50.68%	69.63%	83.17%	0.721
Hoffer QST PK	-0.023	0.725	0.549	0.432	33.27%	55.71%	72.34%	84.53%	0.725
Hoffer QST	0.071	0.732	0.567	0.466	29.98%	52.22%	71.95%	82.98%	0.735
Shammas-PL	-0.447	0.661	0.648	0.550	22.63%	46.42%	64.22%	77.76%	0.798
Haigis-L	-0.454	0.678	0.661	0.563	20.89%	46.23%	63.25%	78.72%	0.815

The EVO PK, EVO, Barrett True-K PK, and PEARL-DGS TK formulas using total keratometry values perform with higher accuracy than the traditional legacy formulas.

Dr. Yeo's study concluded that the EVO PK, EVO, Barrett True-K PK, and PEARL-DGS TK formulas were the most accurate. Utilizing TK or PK values improved the outcomes for all formulas. The legacy Haigis-L and Shammas-PL

formulas resulted in the lowest accuracy with a myopic error tendency. "Always use measured PK from TK for post-LVC IOL calculations," Dr. Yeo reminded the audience.

Another aspect Dr. Yeo discussed was whether using measured posterior corneal astigmatism (PCA) is of any benefit in toric IOL calculations. In eyes with a measured PCA of 0.5 D or more, the Barrett toric calculator using measured PCA instead of predicted PCA provided more accurate IOL outcomes.^{12,13} In his own paper, Dr. Yeo found a benefit in using measured PCA for eyes with non-vertical PCA for both the Barrett and EVO formulas.¹⁴

Finally, in eyes with keratoconus, formulas using TK performed the best. "Results from studies showed that the Barrett True-K with PK did the best in both severe and non-severe keratoconus," Dr. Yeo said. Additionally, "even though the EVO is not a keratoconus formula, it was reported that with TK, it actually works in non-severe keratoconus."

In summary, Dr. Yeo reiterated that TK really benefits IOL calculations in eyes with atypical corneas: post-LVC, toric IOL calculations where measured PCA is high or non-vertical, and keratoconus eyes. "In the past, it was much more challenging for us as surgeons because we had to do calculations manually," Dr. Shetty commented. "But now, with the IOLMaster® 700, where you can get the actual measurement of the posterior cornea, life is becoming easier and easier."

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