# Optimization of Corneal Arcuate Incisions for Improved Refractive Outcomes and Correction of Astigmatism with a Dual-Pulse Femtosecond Laser

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# Disclosures

- LENSAR (I, C)
- Johnson & Johnson Vision (I, C, S)
- SUN Pharmaceuticals (C, S)
- Carl Zeiss Meditech (C)
- Gore (C)
- Oculus Biologics (C)
- Advanced Euclidian Solutions (I, C)


I = Investigator

C = Consultant

S = Speaker

# Introduction

- Femtosecond laser-assisted arcuate keratotomy (FSAK) is an effective method to reduce astigmatism during cataract surgery.
- The consistency and efficacy of FSAK can improve significantly when guided by well-designed nomograms.
- Various nomograms have been developed to be used specifically for femtosecond lasers.
- Optimization/refinements of the existing nomograms help improve their accuracy.
- The present study evaluated the outcomes of femtosecond laser-assisted AK performed with and without nomogram optimization in patients undergoing cataract surgery.

# Purpose

Optimization of arcuate keratotomy (AK) construction was undertaken to drive the reduction of astigmatism and improvement of postoperative uncorrected visual acuity in patients undergoing cataract surgery with a dual-pulse femtosecond laser.

# Methods

| | |
|---|---|
| **Study Design** | Retrospective chart review. |
| **Inclusion Criteria** | Eyes with ≤1.35 D corneal astigmatism and no ocular pathology other than cataract were included. |
| **Study Procedure** | FSAK was performed with the ALLY Adaptive Cataract Treatment System (LENSAR, Orlando, FL).<br>The outcomes of FSAK were assessed in two phases.<br>▪ In the first phase (N = 88 eyes), the Wörtz-Gupta formula using Veracity Software (Carl Zeiss Meditech, Dublin, CA) was used to construct AK and the outcomes were analyzed.<br>▪ In the second phase (N = 59 eyes), the Wörtz-Gupta formula was optimized within Veracity to construct AK, all Aks were opened at the time of surgery, and the outcomes were analyzed. |
| **Outcome Measures** | Preop and postop astigmatism, MRSE, UDVA at 4 to 6 weeks postoperative. |

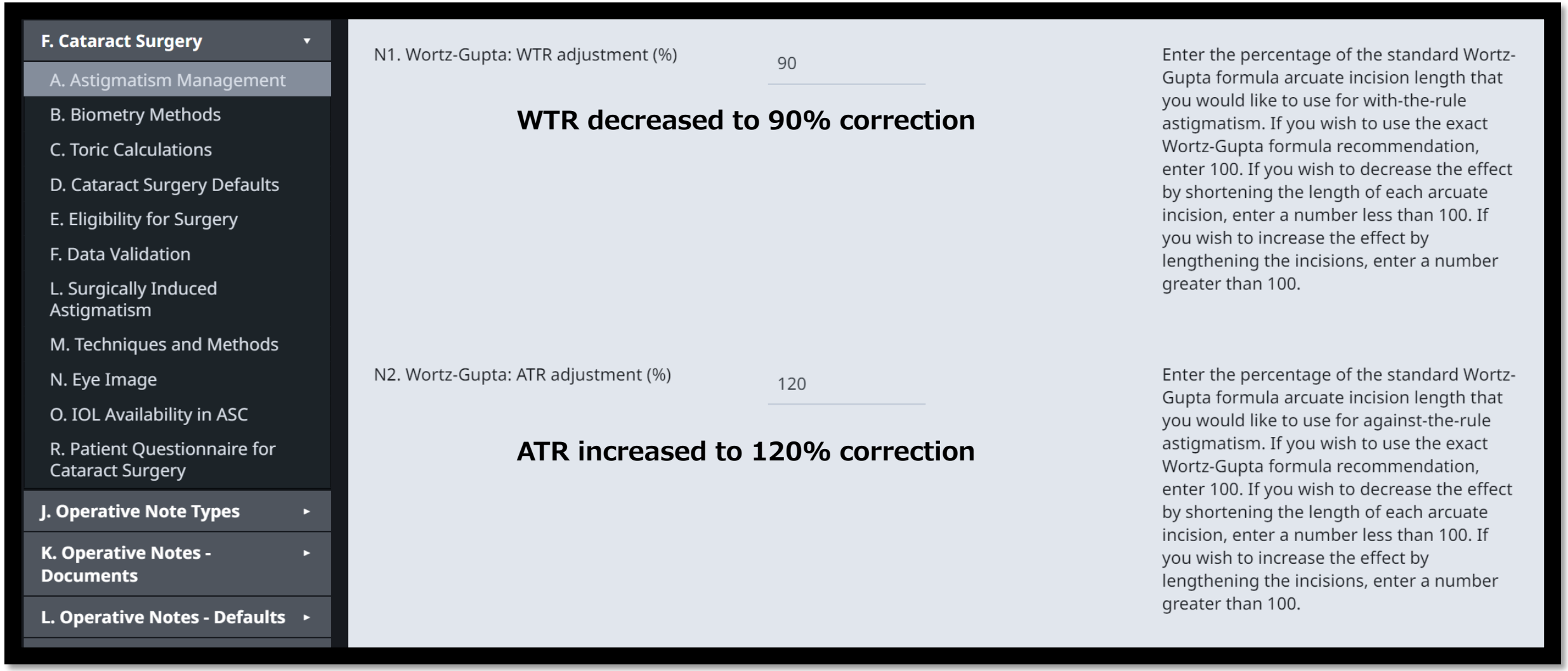
# Methods: Vector Analysis

- Pre-optimization Vector analysis of refractive and keratometric changes[1, 2]

| Vector analysis of refractive and keratometric changes | | | | | |
|---|---|---|---|---|---|
| N | | 88 | | | |
| Properties | | Mean | SD | Minimum | Maximum |
| Change in corneal (keratometric) astigmatism, D | Total | 0.66 | 0.56 | 0.05 | 2.75 |
| | along original steep keratometry meridian | 0.34 | 0.67 | -1.13 | 2.25 |
| | along Orthogonal to steep keratometry meridian | 0.07 | 0.44 | -0.83 | 2.12 |
| Percentage of keratometric to refractive correction# | | 103.74% | 375.18% | -2266% | 2026.16% |
| Efficacy ratio (ratio of SIA along the steep axis (cos) to preoperative keratometric cylinder) | | 68.97% | 133.18% | -157.06% | 608.83% |

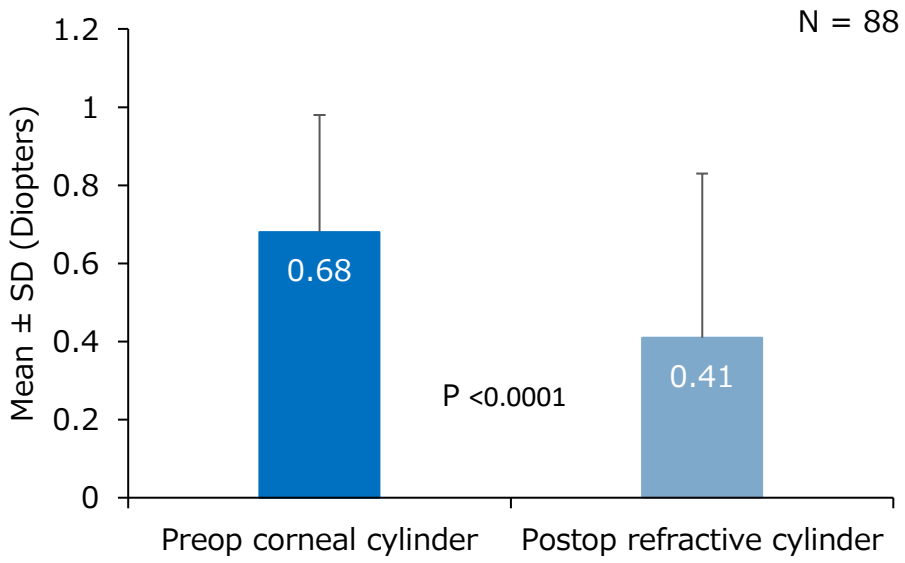

1. Alpins N. Astigmatism analysis by the Alpins method. J Cataract Refract Surg. 2001 Jan;27(1):31-49.
2. Blehm C, Potvin R. Pseudophakic astigmatism reduction with femtosecond laser-assisted corneal arcuate incisions: a pilot study. Clin Ophthalmol. 2017 Jan 23;11:201-207.

# Astigmatism Management (in Veracity)

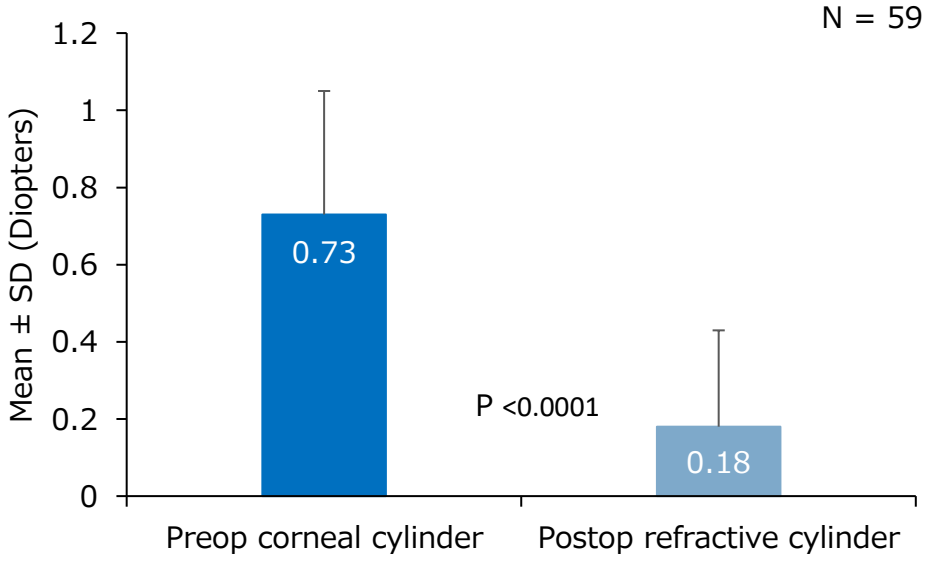


# Results: Mean Astigmatism

## Pre-optimization



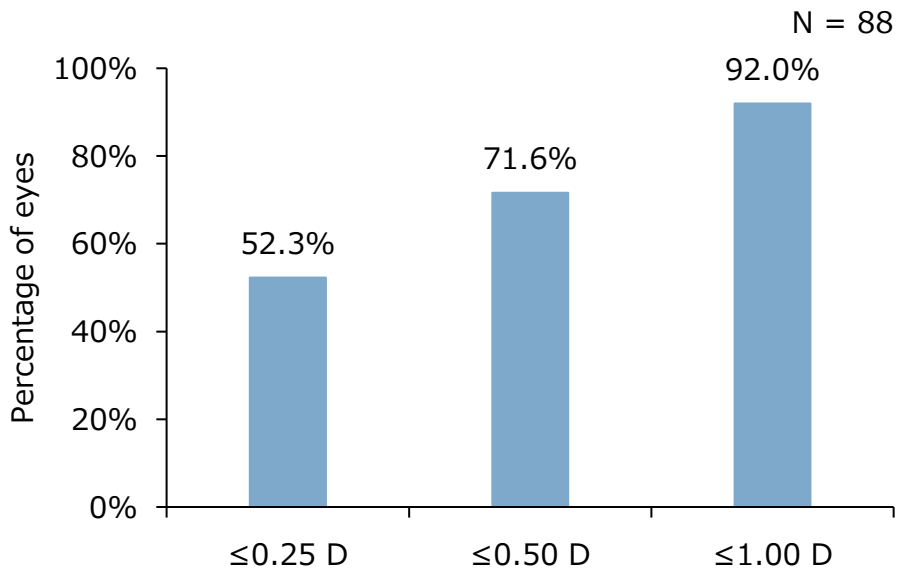

## Post-optimization



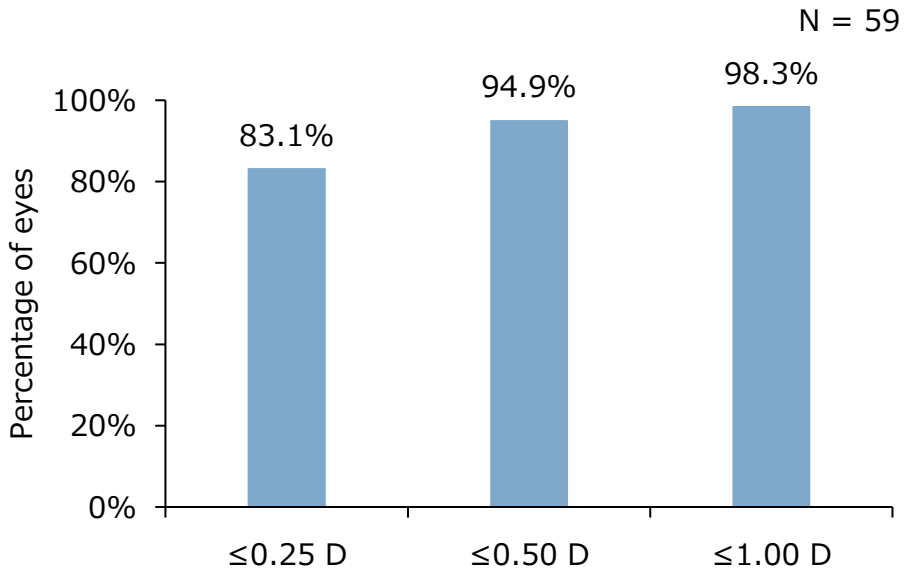

- While astigmatism reduced from preop to postop in both groups, the mean reduction in astigmatism was greater when the AKs were performed using the optimized nomogram.

# Results: Residual Refractive Cylinder

**Pre-optimization residual refractive cylinder**



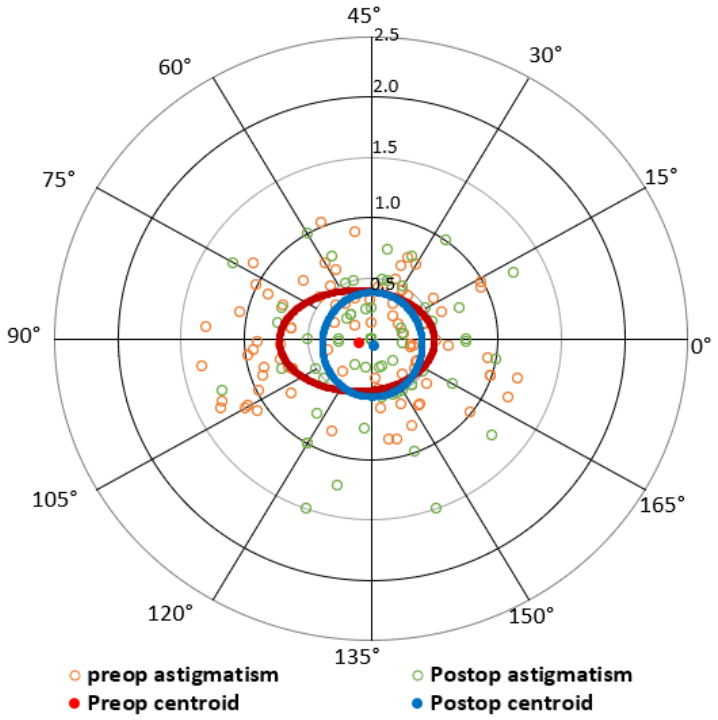

**Post-optimization residual refractive cylinder**



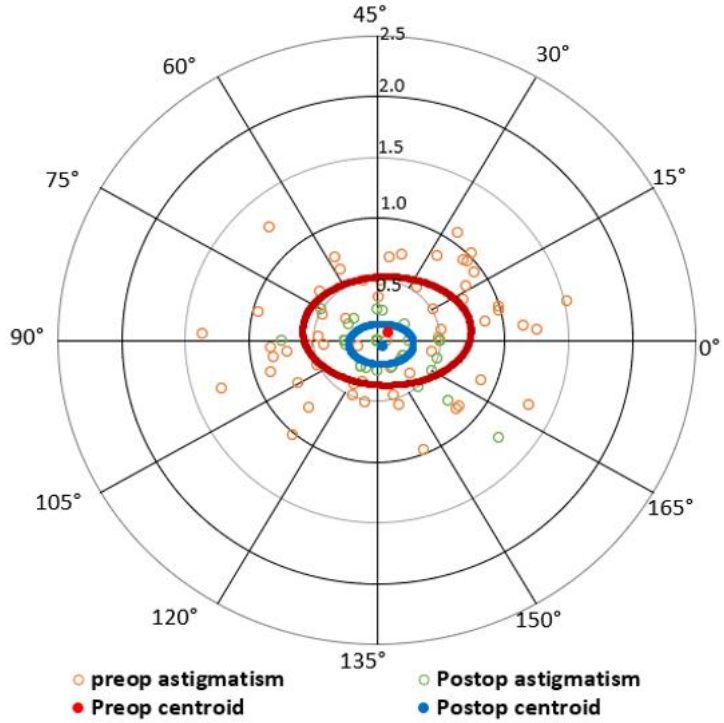

- The proportion of eyes achieving a postoperative residual cylinder within 0.5 D was higher (95% vs 72%) when AKs were performed using an optimized nomogram.

# Results: Double-angle Vector Plot

## Pre-optimization




## Post-optimization

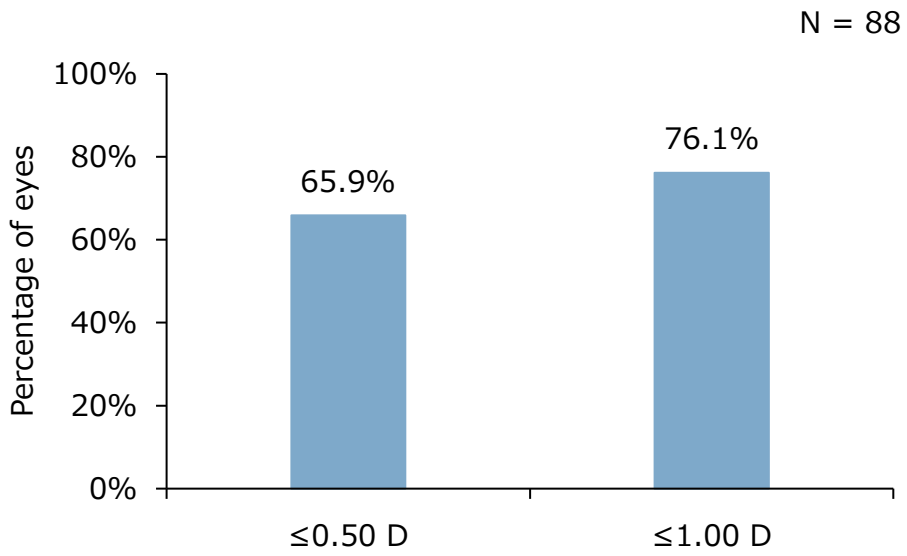



- AKs performed using the optimized nomogram resulted in a smaller vectoral standard deviation (represented by an ellipse) than when the AKs were performed without nomogram optimization.

# Results: Postoperative MRSE

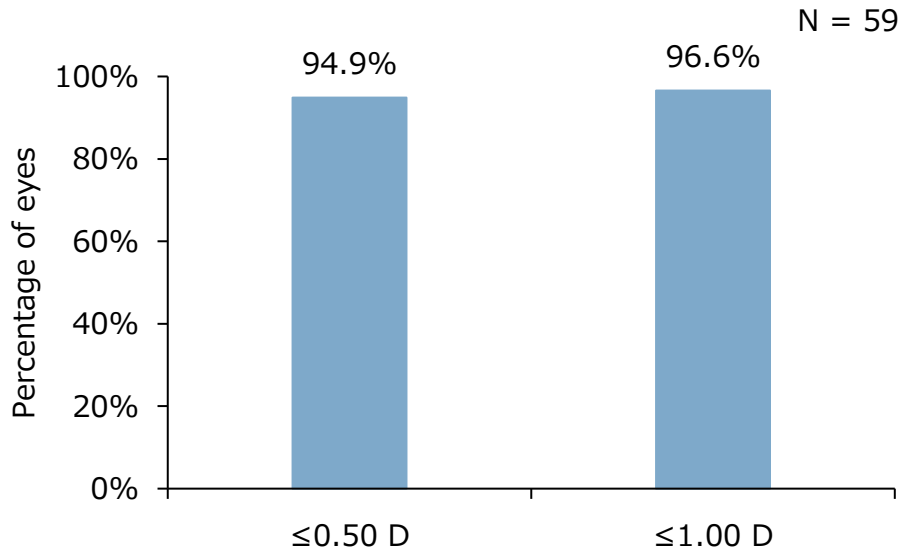
**Pre-optimization**

**Mean MRSE: -0.49 ± 0.77 D**




**Post-optimization**

**Mean MRSE: -0.10 ± 0.37 D**

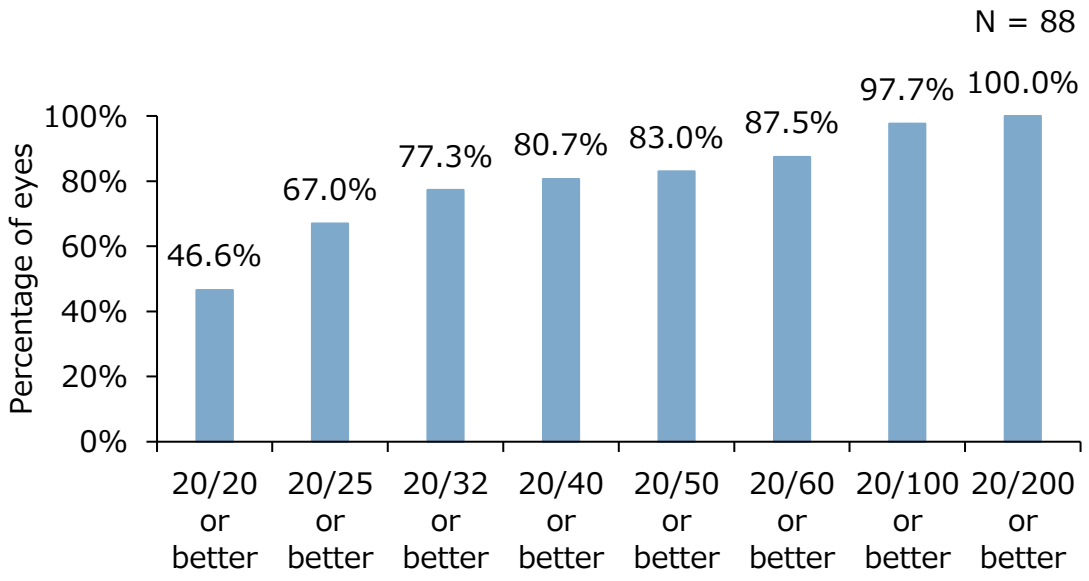



- Mean postop MRSE was less myopic and had a higher proportion of eyes achieving MRSE within 0.5 D when the AKs were performed using the optimized nomogram.

# Results: Postoperative UDVA

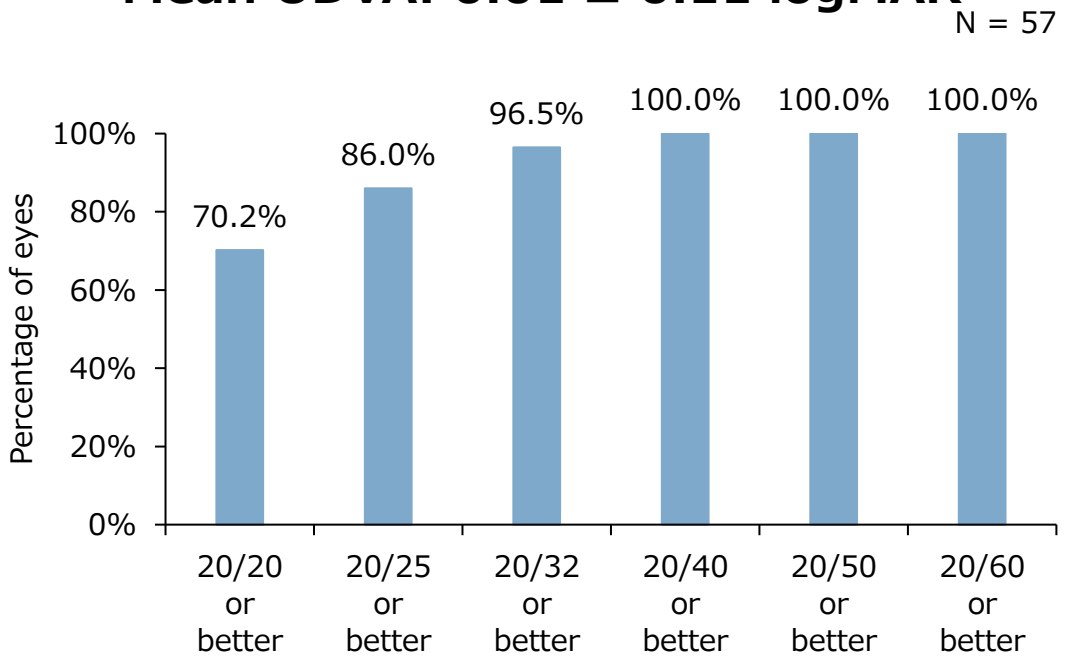
## Pre-optimization

**Mean UDVA: 0.16 ± 0.25 logMAR**




## Post-optimization

**Mean UDVA: 0.01 ± 0.11 logMAR**




- AK performed with the optimized nomogram showed excellent visual outcomes, with 96.5% of eyes achieving postoperative UDVA 20/32 or better compared to 77.3% without nomogram adjustment.

# Discussion and Conclusion


- Evaluating the outcomes of FSAK ensures consistency, enables continuous quality improvements, and guides surgeons in refining the nomogram.
- The use of the Wörtz-Gupta formula (in the first phase) to construct AKs showed good results, however, with room for further improvement.  Only about 1/3 surgeons opened up arcuate incisions at time of surgery.
- In the second phase, the existing nomogram was optimized for arc length and was used to construct AKs.  All surgeons (3/3) opened up arcuate incisions at time of surgery.
  - Outcomes of FSAK performed with the optimized nomogram resulted in excellent astigmatic outcomes.
  - In addition, the use of an optimized nomogram resulted in improved UDVA in these patients compared to patients who underwent AK without nomogram adjustments.
- Nomogram-based planning tool of LENSAR's ALLY dual-pulse femtosecond laser offers convenient AK planning and optimizes outcomes by allowing modifications in the pre-programmed nomogram data.
- Wireless data transmission from digital devices to the ALLY laser allows for a quick iris registration process and the placement of AK incisions at the exact location of astigmatism with no cyclotorsion errors.

# Thank You