

## Effect of Corneal Opacity on LASIK Flap Creation With the Femtosecond Laser

### To the Editor:

I read the recent article by Tomita et al, which appeared in the January 2012 issue of the *Journal of Refractive Surgery*,<sup>1</sup> and would like to offer some comments.

Tomita et al, in their retrospective study, investigated the respective incidence of vertical gas breakthrough (VGB) for patients with corneal opacity undergoing Femto LDV (Ziemer Ophthalmic Systems AG, Port, Switzerland) and IntraLase FS 60 (Abbott Medical Optics Inc, Santa Ana, California) femtosecond laser flap creation for LASIK, and reached a conclusion that VGB with the IntraLase FS 60 is more common than that with the Femto LDV. Eyes included in the “IntraLase group” had corneal flaps of 100- to 130- $\mu\text{m}$  thickness, whereas eyes in the “LDV group” had only 90- $\mu\text{m}$  thickness corneal flaps. Although the creation of a thinner corneal flap did not induce any cases of VGB in the LDV group thought to be potentially associated with the relatively thin depth setting, the study, not well-matched with corneal flap thickness, may have produced confounding outcomes. Also, the authors should have specified where in the cornea the opacity was located and whether the femtosecond laser was focused on the scar plane to dissect the stroma for a flap creation, as these specifications would be helpful in interpreting the results presented.

Occurrence of VGB during femtosecond laser flap creation is rare and considered to be causatively linked with a focal area of altered epithelium and thinned stroma occurring with corneal scars.<sup>2</sup> If the femtosecond laser is directed to focus on the scar plane, some of the generated microbubbles are likely to coalesce into a bigger gas bubble and escape through the low resistance pathway to the surface, rather than progress with the advancing lamellar plane. With this understanding, the flap interface in this study may be either anterior or posterior to the corneal opacity (not documented in the article) to avoid the potentially imperfect photodisruption. As such, the difference in the incidence of VGB between the two groups could be attributed to the different photodisruption processes determined by the physical features of the two femtosecond laser systems.

The cutting process of the IntraLase FS 60 femtosecond laser is driven by mechanical forces with a shockwave of approximately 4  $\mu\text{m}$ ,<sup>3</sup> which is more likely to cause VGB as demonstrated in this study; the cutting process of the Femto LDV femtosecond laser is confined by the spot size <1  $\mu\text{m}$ ,<sup>4</sup> and may explain

why no VGB occurred in the LDV group even with a thinner corneal flap. However, there is a possibility that corneal opacity is adjacent to and well beneath the flap interface, which may predispose to VGB especially when the corneal stroma is dissected with a femtosecond laser-induced mechanical shockwave. I believe this study would be strengthened with a more definite specification.

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*The author has no financial or proprietary interest in the materials presented herein.*

### REFERENCES

1. Tomita M, Chiba A, Matsuda J, Nawa Y. Evaluation of LASIK treatment with the Femto LDV in patients with corneal opacity. *J Refract Surg.* 2012;28(1):25-30. doi: 10.3928/1081597X-20111213-01
2. Seider MI, Ide T, Kymionis GD, Culbertson WW, O'Brien TP, Yoo SH. Epithelial breakthrough during IntraLase flap creation for laser in situ keratomileusis. *J Cataract Refract Surg.* 2008;34(5):859-863.
3. Zhang ZY, Chu RY, Zhou XT, et al. Morphologic and histopathologic changes in the rabbit cornea produced by femtosecond laser-assisted multilayer intrastromal ablation. *Invest Ophthalmol Vis Sci.* 2009;50(5):2147-2153.
4. Lubatschowski H. Overview of commercially available femtosecond lasers in refractive surgery. *J Refract Surg.* 2008;24(1):S102-S107.

### Reply:

We thank Dr Zhang for his comments regarding our article.<sup>1</sup> When we created 90- $\mu\text{m}$  LASIK flaps using the IntraLase FS 60 (Abbott Medical Optics Inc, Santa Ana, California) in patients with corneal opacity, we often experienced vertical gas breakthrough (VGB). In our study, we explained the characteristics of the IntraLase FS 60 and Femto LDV (Ziemer Ophthalmic Systems AG, Port, Switzerland). When the IntraLase FS 60 is used for flap creation, the flap is created by dissecting a flap interface followed by a side cut. If defects are present in the Bowman layer due to corneal opacity, the gas produced when cutting a flap interface may break through the damaged part of the Bowman layer and escape underneath the epithelium. The damaged part of the cornea may heal, but the wound does not return to its original structure.<sup>2</sup> Because there is no side cut at this stage, the produced gas does not have a way to escape. In contrast, the Femto LDV dissects the flap interface and the side cut at the same time. Therefore, any gas produced can escape from the side cut and does not cause VGB even when a 90- $\mu\text{m}$  flap is created.

Dr Zhang suspected that the flap interface in our study may have been either anterior or posterior to the

TABLE  
**Opacity Levels**

Opacity Level*	Percentage of Eyes	
	Femto LDV Group (n=205)	IntraLase Group (n=200)
Light (up to 110 $\mu\text{m}$ )	33.2	20.0
Medium (up to 120 $\mu\text{m}$ )	49.7	72.5
Heavy (up to 130 $\mu\text{m}$ )	17.1	7.5

\*Depth from the surface of cornea.

corneal opacity. Corneal opacity observed in LASIK patients is generally caused by previous infections triggered by contact lens wear. In these cases, the opacity developed from underneath the epithelium into the stroma without a break.<sup>3</sup> Our observations of the depth of the opacity by slit-lamp in this study are shown in the Table. In most cases, if a 90- $\mu\text{m}$  flap is created, the laser would dissect through the corneal opacity. To ensure an adequate distance between the dissecting surface and the epithelium, flaps created with the IntraLase FS 60 were on average 19- $\mu\text{m}$  thicker to avoid VGB in patients with corneal opacity. However, 27 cases of VGB occurred. If we had created 90- $\mu\text{m}$  flaps using the IntraLase FS 60 for these corneal opacity patients, the incidence of VGB may have been significantly higher than reported in our study.

Flap creation time was approximately the same for both femtosecond lasers. As Dr Zhang mentioned, the cutting process of the two lasers is different. The amount of gas produced by one laser pulse and its shockwave is larger when using the IntraLase FS 60.<sup>4</sup> However, because the spot size and subsequent gas production from photodisruption is small with the Femto LDV, flap creation needs approximately 10 times more laser pulses. Therefore, we hypothesized that the total gas produced using the Femto LDV should be approximately the same as that of the IntraLase FS 60.

Most of the corneal opacity observed in LASIK candidates was caused by infections triggered by contact lens wear. The opacity would have developed from just underneath the epithelium to the stroma and the Femto LDV could not have avoided corneal opacity when 90- $\mu\text{m}$  flaps were created. We believe the location of corneal opacity in the cornea does not affect the discussion of our study.

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## REFERENCES

1. Tomita M, Chiba A, Matsuda J, Nawa Y. Evaluation of LASIK treatment with the Femto LDV in patients with corneal opacity. *J Refract Surg.* 2012;28(1):25-30. doi: 10.3928/1081597X-20111213-01
2. Cintron C, Szamier RB, Hassinger LC, Kublin CL. Scanning electron microscopy of rabbit corneal scars. *Invest Ophthalmol Vis Sci.* 1982;23(1):50-63.
3. Khurana RN, Li Y, Tang M, Lai MM, Huang D. High-speed optical coherence tomography of corneal opacities. *Ophthalmology.* 2007;114(1):1278-1285.
4. Lubatschowski H. Overview of commercially available femtosecond lasers in refractive surgery. *J Refract Surg.* 2008;24(1):S102-S107.

## Astigmatic Neutrality in 1.9-mm Coaxial Microincision Phacoemulsification

### To the Editor:

Coaxial microincision cataract surgery (MICS) can now be performed through similar incision sizes to those previously achieved using sleeveless biaxial MICS, ie, <2 mm. However, measurement variation of corneal astigmatism either by keratometers or topographers may mask the astigmatic effect of such small incisions, necessitating the use of a control sample when studying their effect.<sup>1</sup> Knowing that biaxial MICS is astigmatically neutral, we set out to assess the astigmatic effect of coaxial MICS in a sufficiently powered study, controlling for observer variation of keratometry readings.<sup>1,2</sup>

In a single center, observational, nonrandomized, controlled trial, 35 eyes from 31 patients underwent coaxial MICS using the Bausch & Lomb Stellaris phacoemulsification machine (Bausch & Lomb, Rochester, New York). An Akreos MI60 intraocular lens (IOL; Bausch & Lomb) (27 eyes) or an Acri.Smart IOL (Carl Zeiss Meditec, Jena, Germany) (8 eyes) was inserted using a wound-assisted technique via an unenlarged 1.8-mm incision. The internal dimension of both incisions was measured using an internal incision gauge (Incision Gauge 0.7 to 2.4 mm, code 2000-05; Capital Instruments Ltd, Bellevue, Washington) after insertion of the IOL and the meridian placement of both incisions was confirmed at the end of the procedure. The main phacoemulsification incision mean width was  $1.92 \pm 0.08$  mm. To aid incision closure, both incisions were hydrated. No incisions were sutured. On the first postoperative day, the meridian incision placement was confirmed at the slit-lamp. Pre- and postoperative keratometry readings after 6 weeks were used for vector analysis according to the Alpíns method.<sup>3</sup> Vector analysis of the alteration of the keratometric cylinder was compared to 74 control eyes not undergoing surgery that underwent keratometry using the same keratometric device over a similar time frame.

Preoperative exclusion criteria for the control and

TABLE

### Vector Analysis of Astigmatic Change: Coaxial Microincisional Phacoemulsification Versus Nonsurgical Controls

	Surgical Group (n=33)	Control Group (n=74)	P Value
SIA (D) in surgical cases and the equivalent AMV (D) in controls	0.53±0.36	0.52±0.54	.906
Angular separation of SIA or AMV and main phacoemulsification incision (°)	1.01±48.5	12.1±57.3	.344
Flattening effect at main phacoemulsification incision (D)	0.14±0.51	-0.07±0.57	.073
Torque at main phacoemulsification incision (D)	-0.008±0.37	-0.026±0.49	.857
Angular separation of SIA/AMV and "side port" incision (°)	11.15±50.41	-0.23±44.62	.249
Flattening effect at "side port" incision (D)	-0.05±0.45	0.06±0.42	.240
Torque at "side port" incision (D)	0.12±0.45	-0.04±0.62	.187
Torque effect at preoperative steep K axis (D)	-0.11±0.46	0.02±0.39	.157

SIA = surgically induced astigmatism, AMV = astigmatism measurement variability in control eyes (equivalent to SIA in surgical groups), K = keratometry. Variables are presented as mean±standard deviation; mean values were compared using independent samples t test. Note. In control eyes (no surgery performed), "phacoemulsification incision" site designated as 180° and "side port" site designated as 120°.

intervention groups were previous anterior segment surgery, corneal pathologies, and irregular astigmatism. Postoperative exclusion criteria were complications such as failure to place the IOL in the capsular bag, suturing of the incisions, and any complication necessitating enlargement of the main incision. Preoperative clinical assessment included automated keratometric readings, refraction where possible, visual acuity, intraocular pressure, and anterior and posterior segment evaluation. These assessments were repeated at follow-up 1 day, 1 week, and 6 weeks postoperatively.

No statistically significant difference in surgically induced astigmatism (0.53±0.36 surgical group, 0.52±0.54 control group,  $P=.906$ ) or degree of flattening at the site of the phacoemulsification incision (0.14±0.51 surgical group, -0.07±0.57 control group,  $P=.073$ ) was detected between surgical cases and routine variability of control keratometry (Table). Surgically induced astigmatism of this magnitude, being indistinguishable from keratometry variation in control, nonsurgical eyes, leads to the conclusion that microincision coaxial phacoemulsification using a 1.9-mm incision is astigmatically neutral, similar to a previously published report on 1.8-mm coaxial MICS.<sup>4</sup> An astigmatically neutral coaxial technique removes the necessity for physicians to acquire the new skills of biaxial techniques and allows a more accurate selec-

tion of methods of astigmatism control for use during the primary cataract procedure.

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The authors have no proprietary interest in the materials presented herein.

#### REFERENCES

- Goggin M, Patel I, Billing K, Esterman A. Variation in surgically induced astigmatism estimation due to test-to-test variations in keratometry. *J Cataract Refract Surg.* 2010;36(10):1792-1793.
- Kaufmann C, Krishnan A, Landers J, Esterman A, Thiel MA, Goggin M. Astigmatic neutrality in biaxial microincisional cataract surgery. *J Cataract Refract Surg.* 2009;35(9):1555-1562.
- Alpins NA. Vector analysis of astigmatism changes by flattening, steepening, and torque. *J Cataract Refract Surg.* 1997;23(10):1503-1514.
- Wilczynski M, Supady E, Piotr L, Synder A, Palenga-Pydynd D, Omulecki W. Comparison of surgically induced astigmatism after coaxial phacoemulsification through 1.8 mm microincision and bimanual phacoemulsification through 1.7 mm microincision. *J Cataract Refract Surg.* 2009;35(9):1563-1569.

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