Sub–2-mm Versus 2.2-mm Microincision Coaxial Cataract Surgery

MICS provides excellent long-term functional and morphologic results.

BY LEONARDO MASTROPASQUA, MD; AND LISA TOTO, MD

Faster visual rehabilitation and improved postoperative visual capacity after cataract surgery have maximized surgical outcomes and reduced induced astigmatism. Several studies have shown that the degree of postsurgical corneal astigmatism is related to incision size, particularly for incisions greater than 3 mm.[1,2] Moreover, after standard small-incision cataract surgery with incisions 3 mm or less, there is a degradation of corneal optical quality due to an increase in higher-order aberrations, mainly third-order (trefoil).[3,4] However, these incisions do not induce much astigmatism. Sub–2-mm incisions further reduce the amount of induced astigmatism.[5] With minimal differences between these two techniques, what is the best choice to use with coaxial cataract surgery? Herein, we aim to answer this question.

Microincision cataract surgery (MICS), generally defined as phacoemulsification performed through an incision of 2 mm or less, is now widely used with both bimanual and coaxial instrumentation. Bimanual MICS, typically performed through two 1.7-mm or smaller incisions, decreases induced astigmatism compared with conventional small-incision cataract surgery (SICS) and improves visual performance in pseudophakic patients by preserving their corneal aberrometric patterns.[5-8] Coaxial MICS, performed through an incision of approximately 2 mm, also demonstrates good results with low surgically induced astigmatism.[5] A recent study reported no significant difference in surgically induced astigmatism between the two microincision techniques;[5] however astigmatic control is not the only requirement for faster visual rehabilitation. Trauma to the corneal endothelial cells must also be minimized to ensure the best optical outcomes.

Endothelial cell damage has been evaluated after SICS and MICS, and incision size was not found to influence endothelial cell loss. Phaco time, ultrasound energy, mechanical trauma, corneal manipulation, fluid turbulence, and sleeveless phaco were among the main factors involved in damaging endothelial integrity.[9] Wound integrity has also been addressed, and histologic and in vivo anterior segment optical coherence tomography (AS-OCT) studies of the incision show a greater alteration of tunnel morphology after bimanual MICS compared with conventional SICS and coaxial MICS, particularly due to the use of a sleeveless phaco tip.[10,11]

TABLE 1. INTRAOPERATIVE SURGICAL SYSTEM PARAMETERS

Parameters	1.8-mm coaxial MICS (n=15)	2.2-mm coaxial MICS (n=15)	**P* value
Mean cumulative dissipated energy (CDE)	19.02 ±5.29	12.10 ±2.50	ns
Torsional time (sec)	54.80 ±11.10	42.00 ±11.07	ns
Mean total volume of BBS utilized (cc)	39.50 ±6.13	38.16 ±8.10	ns

**P value Mann-Whitney U test for between-group differences*
ns = not statistically significant

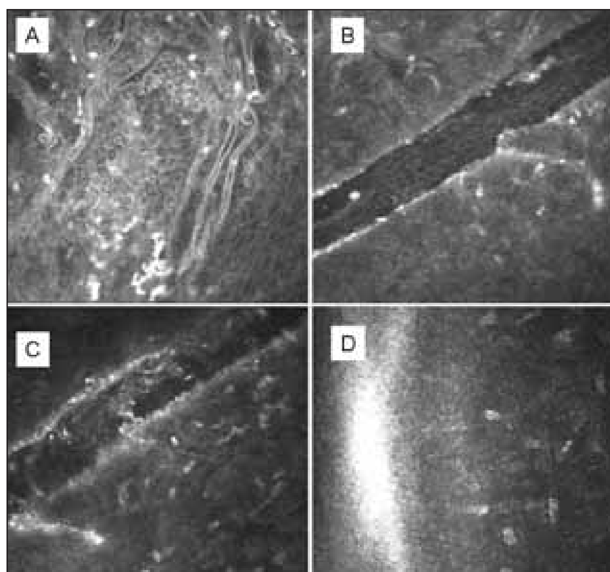

Figure 1. Tunnel morphology of 1.8-mm tunnel by means of in vivo confocal microscopy 1 day postoperatively: (A) mild epithelial disruption; (B) linear wound morphology; (C) mild tissue edema at the margin; and (D) undamaged endothelium.

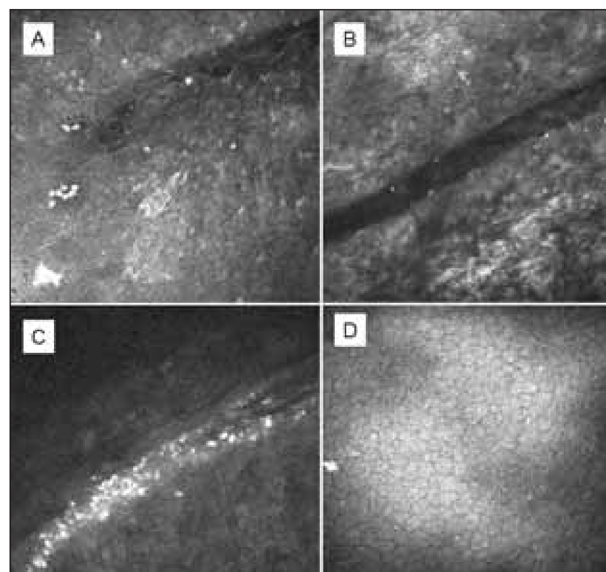

Figure 2. Tunnel morphology of 2.2-mm tunnel by means of in vivo confocal microscopy 1 day postoperatively: (A) minimal epithelial disruption; (B) linear wound morphology; (C) minimal tissue edema at the margin; and (D) undamaged endothelium.

COAXIAL MICS STUDY

We compared 1.8- and 2.2-mm coaxial MICS with torsional ultrasound (Ozil; Alcon Laboratories, Inc., Fort Worth, Texas). Functional and morphological results for each incision size were evaluated over 3 months. The transverse oscillation of the Ozil phaco tip shears the crystalline lens with no repulsion, thus reducing phaco energy compared with traditional phaco.

Fifteen eyes underwent 1.8-mm microcoaxial MICS (group 1) and 15 eyes underwent 2.2-mm microcoaxial MICS (group 2). All surgeries were performed with a divide-and-conquer technique using linear amplitude (100% limit) and continuous torsional phacoemulsification. A 0.9-mm, 30º ABS mini-flared Kelman tip (Alcon Laboratories, Inc.) was used in all patients with the 0.9-mm MicroSmooth Nano Infusion Sleeve in group 1 and the MicroSmooth Ultra Infusion Sleeve (both by Alcon Laboratories, Inc.) in group 2. In all cases, the IOL was implanted with the Monarch III injector and Monarch D Cartridge (Alcon Laboratories, Inc.).

TABLE 2. MEAN CORNEAL ASTIGMATISM AND ASTIGMATISM CHANGE

	1.8-mm coaxial MICS		2.2-mm coaxial MICS		
Exam	Corneal astigmatism	Algebraic difference	Corneal astigmatism	Algebraic difference	*P value
Preop (SD)	1.08 (0.81)		0.84 (0.63)		.462
1 day (SD)	1.20 (0.73)	0.12	1.13 (0.63)	0.29	.935
7 days (SD)	1.38 (0.40)	0.30	1.10 (0.80)	0.26	.391
30 days (SD)	1.24 (0.73)	0.16	0.88 (0.80)	0.04	.257
90 days (SD)	1.23 (0.75)	0.15	0.90 (0.74)	0.06	.261
**P value	0.94		0.12		

**P value Mann-Whitney U test for between-group differences*
***P value Friedman test for comparison of parameters at different time points*

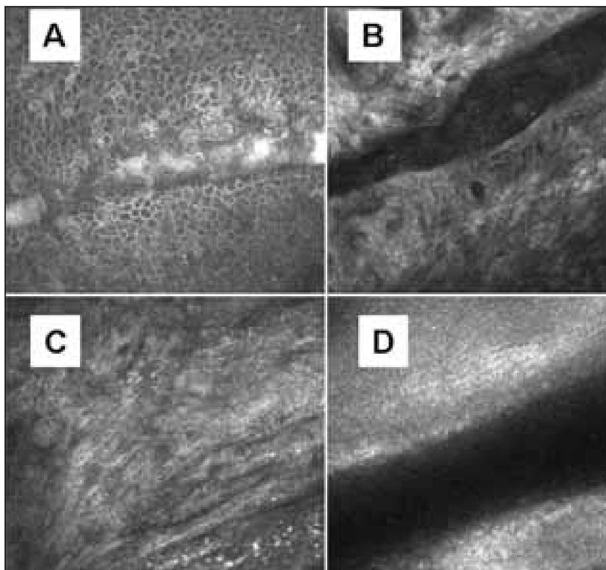

Figure 3. Tunnel morphology of 1.8-mm tunnel by means of in vivo confocal microscopy 90 days postoperatively: (A) restoration of epithelial layer with moderately reflective acellular scar; (B) minimal epithelial downgrowth; (C) posterior stromal healing; and (D) preserved endothelium.

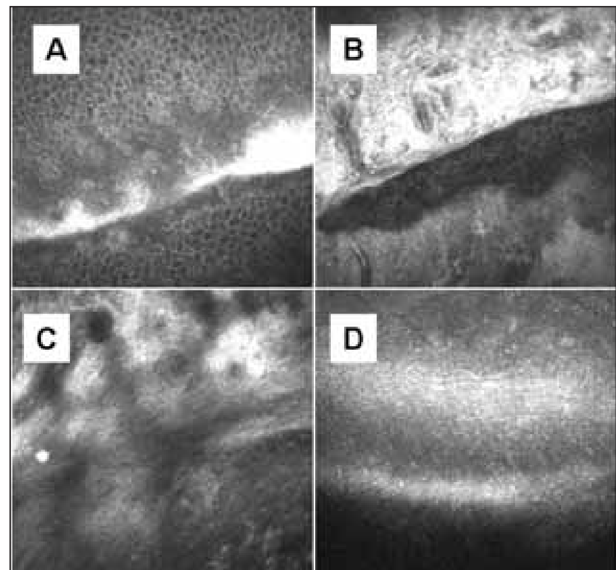

Figure 4. Tunnel morphology of 2.2-mm tunnel by means of in vivo confocal microscopy 90 days postoperatively: (A) restoration of epithelial layer with moderately reflective acellular scar; (B) minimal epithelial downgrowth; (C) posterior stromal healing; and (D) preserved endothelium.

RESULTS

Intraoperative surgical system parameters were not significantly different between the two groups (Table 1), and at 3 months surgically induced astigmatism was minimal in both groups (0.15 D in group 1 and 0.06 D in group 2; *P*=.261; Table 2). Morphologic analysis by in vivo confocal microscopy showed a significant decrease in endothelial cell count at the center of the cornea in both groups, but no statistically significant difference between the groups (Table 3).

On day 1 postoperative, in vivo confocal microscopy of tunnel morphology showed a linear incision in both groups, with slightly greater edema in group 1 (Figures 1 and 2). However, by 30 days, corneal edema had completely disappeared. At 90 days, both groups showed a moderately reflective linear acellular scar with minimal epithelial downgrowth (Figures 3 and 4). On postoperative day 1, tunnel morphometry with the Visante OCT (Carl Zeiss

TABLE 3. MEAN ENDOTHELIAL CELL COUNT AND ENDOTHELIAL CELL CHANGE

	1.8-mm coaxial MICS		2.2-mm coaxial MICS		
Exam	Endothelial cell count (cells/mm²)	Change	Endothelial cell count (cells/mm²)	Change	*P value
Preop (SD)	2,070 (537)		2,400 (421)		.151
1 day (SD)	1,861 (515)	-209	2,150 (441)	-250	.350
7 days (SD)	1,720 (622)	-350	2,055 (412)	-345	.402
30 days (SD)	1,765 (449)	-305	1,966 (115)	-434	.237
90 days (SD)	1,768 (420)	-302	1,977 (125)	-423	.234
**P value	<.05		<.05		

**P value Mann-Whitney U test for between-group differences*
***P value Friedman Ttest for comparison of parameters at different time points*

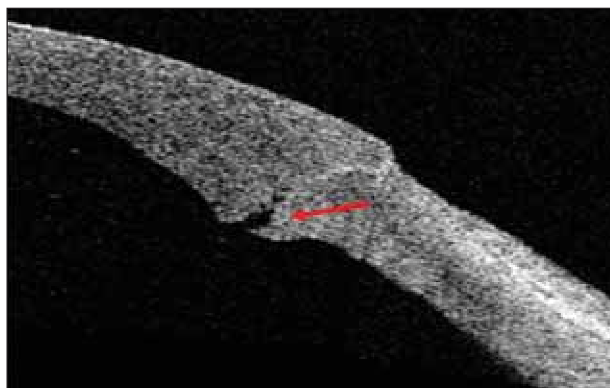

Figure 5. Tunnel morphology of 1.8-mm tunnel showing endothelial gaping.

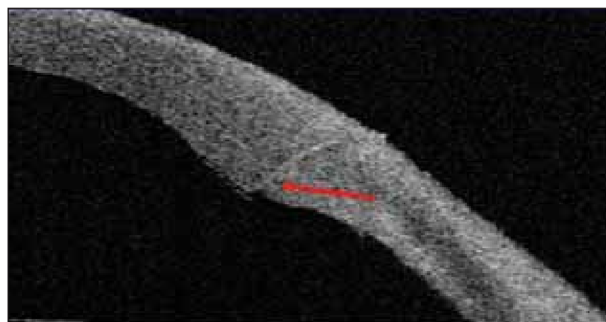

Figure 6. Tunnel morphology of 2.2-mm tunnel showing endothelial misalignment.

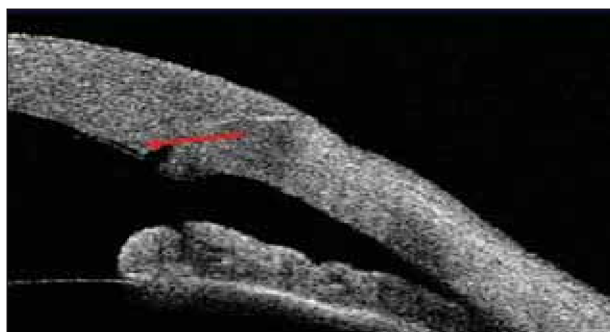

Figure 7. Tunnel morphology of 2.2-mm tunnel showing localized Descemet's detachment.

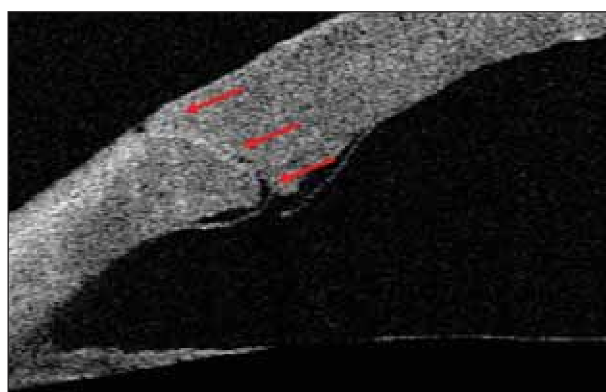

Figure 8. Tunnel morphology of 1.8 mm-tunnel showing loss of coaptation along the tunnel.

Meditec, Jena, Germany) revealed increased corneal thickness at the incision site; it was greater in group 1 compared with group 2 (not statistically significant; *P*=.025). Incisional corneal thickness decreased in both groups during the first postoperative month (Table 4).

Visante OCT assessment showed tunnel architectures that were equally present in both groups, without significant differences: endothelial and epithelial gaping (Figure

TABLE 4. MEAN INCISIONAL CORNEAL THICKNESS AND INCISIONAL CORNEAL THICKNESS CHANGE

	1.8-mm coaxial MICS		2.2-mm coaxial MICS		
Exam	Corneal thickness	Change	Corneal thickness	Change	**P* value
Preop (SD)	0.71 (0.05)		0.72 (0.03)		.562
1 day (SD)	1.12 (0.10)	0.41	1.02 (0.05)	0.30	.025
7 days (SD)	0.95 (0.10)	0.24	0.93 (0.07)	0.21	.659
30 days (SD)	0.84 (0.09)	0.13	0.83 (0.09)	0.11	.635
90 days (SD)	0.82 (0.07)	0.11	0.82 (0.07)	0.10	.632
***P* value	<.05		<.05		

**P value Mann-Whitney U test for between-group differences*
***P value Friedman Ttest for comparison of parameters at different time points*

5); misalignment at the epithelial and endothelial sides (Figure 6); localized detachment of Descemet's membrane (Figure 7); and loss of coaptation along tunnel margins detected most often in one- or two-plane tunnels (Figure 8).

DISCUSSION

Technological advances in recent decades, particularly in phaco techniques and IOL designs and materials, have led to smaller incisions. This, in turn, has led to better safety and efficacy in cataract surgery. This new wave in cataract surgery is increasingly viewed as refractive cataract surgery.

Bimanual and coaxial MICS induce less astigmatism than conventional small-incision phacoemulsification.[5-8] However, when considering the efficacy and safety of cataract surgery, questions about tissue trauma should also be addressed and endothelial cell damage and tunnel integrity evaluated. Several studies have shown that endothelial damage correlates not with incision size but with intraoperative surgical parameters such as phaco time, ultrasound energy, and use of sleeveless phaco.[1]

Bimanual phacoemulsification is thought to create mechanical tunnel damage due to insertion of instruments into a small incision. Tissue damage is also associated with increased temperatures at the incision site due to the sleeveless phaco tip. More edema at the incision site of bimanual MICS procedures compared with coaxial MICS and coaxial SICS techniques confirms the findings of in vivo studies, which have shown greater alteration of the tunnel anatomy with sleeveless versus sleeved phacoemulsification.[10]

In our study, two incision sizes (1.8 and 2.2 mm) showed low amounts of surgically induced astigmatism, thus demonstrating that for slightly over or sub–2-mm incisions, induction of astigmatism is negligible. We also confirmed that incision size does not influence endothelial cell damage.

We observed a slightly greater difficulty in IOL insertion with 1.8-mm coaxial MICS, which is probably due to the mismatch between the dimensions of the Monarch D Cartridge and the tunnel. We hypothesize that this mechanical stress caused the greater edema with 1.8-mm coaxial MICS. However, no differences in tunnel morphology or morphometry were observed between the two groups after the first month. As already suggested in the literature, we believe that different patterns of tunnel morphology are related to incision angle, intraocular pressure, corneal edema, and mechanical trauma.[12]

TAKE-HOME MESSAGE

- Incision size with SICS and MICS does not influence endothelial cell loss.
- MICS induces less astigmatism than SICS.
- Intraoperative parameters such as phaco time, ultrasound energy, and use of sleeveless phaco influence endothelial damage.

CONCLUSION

Coaxial MICS with 1.8- or 2.2-mm incisions allows excellent long-term functional and morphologic results, thus demonstrating the safety and efficacy of a sleeved-tip microincision procedure. ■

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