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Comparison of 1.8-mm incision versus 2.75-mm incision cataract surgery in combined phacoemulsification and 23-gauge vitrectomy

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ABSTRACT.

Purpose: **To compare 1.8 mm micro-incision and 2.75 mm standard incision in coaxial cataract surgery combined with 23-Gauge (23G) vitrectomy with respect to intraoperative and postoperative complications and outcomes.**

Methods: **In this prospective study 30 eyes of 30 patients planned for combined phacoemulsification and 23G vitrectomy were enrolled, and randomized to undergo either Standard 2.75 mm Incision Cataract Surgery (SICS, 15 eyes) or Coaxial 1.8 mm Micro-Incision Cataract Surgery (C-MICS, 15 eyes) followed by vitrectomy. Inclusion criteria were cataract and macular disorders including macular hole, epiretinal membrane and vitreomacular traction. Data were collected at preoperative evaluation and 1 and 12 months or more after surgery.**

Results: **Incision leakage occurred in two eyes (7%: one per group), retinal break in nine (30%: four in C-MICS, five in SICS). Fibrin in anterior chamber (AC) occurred day 1 in three eyes (10%: two C- and one SICS). Posterior capsule opacification developed in 22 eyes (78%: 13 MICS, nine SICS, $p = 0.1$). A myopic shift of -0.63 ± 0.7 was noted (-0.59 ± 0.8 MICS, -0.68 ± 0.6 SICS, $p = 0.74$). Surgically induced astigmatism (SIA) was significantly smaller in C-MICS group (ΔKP, -0.019 ± 0.095 versus -0.141 ± 0.219, $p = 0.0038$) at 1 month but not at final follow-up (ΔKP, 0.0005 ± 0.16 in C-MICS versus -0.057 ± 0.12, $p = 0.3$**

Conclusions: **Both techniques were equally safe with respect to intraoperative and postoperative findings. Coaxial micro-incision cataract surgery (C-MICS) was associated with less surgically-induced astigmatism (SIA) 1 month after surgery but differences were not statistically significant at final follow-up indicating a faster refractive recovery with C-MICS than with SICS.**

Key words: cataract – micro-incision – phacoemulsification – phacovitrectomy – surgically induced astigmatism – vitrectomy

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Introduction

Phacovitrectomy is a widely performed procedure where a cataractous lens is removed in the same session as a planned posterior pars plana vitrectomy (PPV). It has many advantages including fast visual acuity rehabilitation and clear visualization during vitrectomy (Steel 2007; Villegas et al. 2014). In addition, there is an ongoing trend to operate through smaller incisions in both vitreoretinal and cataract surgery (Fine et al. 2004; Alio et al. 2005, 2006; Dosso et al. 2008; Oshima et al. 2010; Thompson 2011; Wilczynski et al. 2011). Small gauge vitrectomy has become a standard technique in vitreoretinal surgery and it can be performed through either 23G, 25G or 27G incisions (Oshima et al. 2010; Thompson 2011; Osawa & Oshima 2014). In micro-incision cataract surgery (MICS) phacoemulsification is performed through a sub-2 mm incision (Alio et al. 2005, 2006). Micro-incision cataract surgery can be divided into coaxial micro-incision cataract surgery (C-MICS; where a single instrument provides both irrigation and phacoemulsification) and biaxial micro-incision cataract surgery (B-MICS) with separated irrigation and phacoemulsification instruments (Fine et al. 2004; Dosso et al. 2008). Combined C-MICS or B-MICS and small-gauge vitrectomy offers the combined advantages of MICS associated with less wound leakage, good anterior chamber (AC) stability and safety together with small-gauge vitrectomy providing decreased inflammation and faster rehabilitation after surgery (Schonfeld 2013; Czajka et al. 2014; Jalil et al. 2014). In a retrospective study, we previously demonstrated the feasibility of the combined C-MICS and 23G vitrectomy (Czajka et al. 2014). There is, however, to our knowledge no prospective study examining possible advantages of this combined technique.

Accordingly, the aim of the present study was to compare safety and outcomes of combined 1.8 mm incision C-MICS and 23G PPV with 2.75 mm clear corneal standard incision cataract surgery (SICS) with 23G PPV.

Patients and Methods

In a prospective, randomized comparative study, 30 patients (30 eyes) were enrolled. The study followed the tenets of the Helsinki Declaration and was approved by the Linköping Regional Human Ethical Review Committee. All patients provided written consent before the intervention. Participants were randomized to one of two groups (15 eyes per group). In the first group patients were operated with standard combined phacoemulsification with 2.75 mm incision (SICS) and 23-G vitrectomy. In the second group combined 1.8 mm incision C-MICS and 23-G vitrectomy was performed. All surgeries were performed at Linköping University Hospital by two surgeons (MC, BJ), between December 2011 and February 2014. The inclusion criteria were cataract and macular disorders including macular hole (MH), epiretinal membrane (EM) and vitreomacular traction (VMT) and axial length between 20 and 25 mm. Eyes with irregular astigmatism and astigmatism ≥ 3D; traumatic, congenital or complicated cataract; eyes with earlier surgery, prior or current inflammation or infection, glaucoma, optic atrophy, macular degeneration other than MH, or diabetic retinopathy were excluded from the study. Patients were followed-up at 4–5 weeks and then at least 12 months after surgery. One patient in the SICS group died before final examination and one patient in the C-MICS group declined the final examination, leaving 28 patients completing the study. Each patient underwent detailed preoperative and postoperative examination including assessment of best-corrected visual acuity, measurement of intraocular pressure (IOP) by Goldmann applanation tonometry, and assessment of corneal, lens and posterior segment status. For analysis, visual acuity was converted into the logarithm of the minimum angle of resolution (logMAR). Biometry was performed with the IOLMasterTM 500 (Carl Zeiss, Oberkochen Germany). An auto Kerato-Refractometer (Topcon KR-800s, Tokyo, Japan) was used for objective refraction and keratometry postoperatively. All macular optical coherence tomography (OCT) scans were obtained using Spectral-Domain OCT (Heidelberg Engineering, Heidelberg Germany). Intraocular lens (IOLs) power was calculated using Haigis' formula. Table 1 shows patient data, indications and type of cataract.

Surgeries were performed with the Stellaris Vision Enhancement System for C-MICS and SICS (Bausch & Lomb, Aliso Viejo, CA, USA) and the Accurus 2500 surgical system (Alcon Laboratories, Fort Worth, TX, USA) for vitrectomy in 30 eyes. All patients had lens opacification at the time of combined surgery.

Surgical techniques

After informed consent was obtained, patients underwent surgery under general anaesthesia. In the SICS group, a 2.75 mm clear corneal incision for cataract surgery was made at the 9-o'clock position (0° from the horizontal baseline) for the right eye and between 9 and 12 o'clock position (0°–90° from the horizontal baseline) for the left eye. In the C-MICS group, the clear corneal incision was 1.8 mm. For the side instrument an approximately 0.5 mm limbal incision was made 2–3 clock hours left of the main incision. After clear corneal incisions were created, viscoelastic was injected into AC. A 5–6 mm continuous curvilinear capsulorhexis was performed with micro capsulorhexis forceps (DORC Ophthalmic, Zuidland, the Netherlands) suitable for 1.8 mm incision. After hydrodissection and rotation, the nucleus was removed using the chop technique. The cortex was removed and the capsular bag was filled with viscoelastic. A hydrophilic, acrylic, foldable IOLs (Akreos MI 60; Bausch & Lomb) was placed in the capsular bag. The viscoelastic was then removed and the corneal wound was hydrated with balanced salt solution in the C-MICS group. In the SICS group, the corneal incision was closed with a 10–0 nylon suture. The C-MICS incision was hydrated and checked for water tightness. Vitreous surgery was performed using a 23-gauge vitreous cutter driven by the vitrectomy unit and a one-step system. Vitrectomy included complete removal of the posterior vitreous and extensive removal of peripheral vitreous. In some patients, vitrectomy was combined with other procedures including EM or/and internal limiting membrane (ILM) peeling. MembraneBlue-Dual® (MB) and ILM-Blue® (DORC Ophthalmic) were used for EM peeling and ILM peeling, respectively. Triamcinolone acetonide suspension (Vitreal

Table 1. Preoperative clinical characteristics.

Variable	Overall	Group 1 MICS (*n* = 15)	Group 2 SICS (*n* = 15)	p-value
Gender (%)				
Male	10 (33)	7 (47)	3 (20)	0.24
Female	20 (67)	8 (53)	12 (80)	
Mean age (years)	69.6 ± 5.6	70.5 ± 5.5	68.6 ± 5.7	0.35
Eye (%)				
Right	18 (60)	9 (60)	9 (60)	
Left	12 (40)	6 (40)	6 (40)	
IOP (mmHg)	14.3 ± 2.7	14 ± 2.8	14.7 ± 2.7	0.51
Axial length (mm)	23.56 ± 0.72	23.71 ± 0.62	23.40 ± 0.79	0.25
Anterior chamber depth (mm)	3.23 ± 0.32	3.27 ± 0.32	3.16 ± 0.31	0.42
Preoperative BCVA (logMAR)	0.68 ± 0.31	0.50 ± 0.25	0.85 ± 0.27	0.001
Cataract score (%)				
Mild nuclear sclerosis ± cortical spoking	18 (60)	8 (53)	10 (67)	0.5
Moderate	12 (40)	7 (47)	5 (33)	
Indication (%)				
Macular hole	11 (37)	2 (13)	9 (60)	0.01
ERM	15 (50)	11 (73)	4 (27)	0.03
VMT	4 (13)	2 (13)	2 (13)	

MICS = micro-incision cataract surgery, SICS = standard incision cataract surgery, IOP = intraocular pressure, BCVA = best corrected visual acuity, logMAR = logarithm of minimum angle of resolution, ERM = epiretinal membrane, VMT = vitreomacular traction.

S®, Sooft Italia S.p.A, Italy) was used in 15 patients to visualize vitreous during posterior vitreous detachment (PVD) or to decrease macular oedema. Fluid-air or gas exchange was done in all eyes.

Infection prophylactic routines consisted of rinsing the conjunctival sac of the eye to be operated on with chlorhexidine solution 0.05% (Klorhexidinlösning; Kabi Fresenius, Uppsala, Sweden). The skin around both eyes was carefully swabbed with chlorhexidine alcohol 0.5% (Klorhexidinsprit; Kabi Fresenius). No antibiotic was added to the irrigation fluid. In all eyes 1 mg cefuroxime (Zinacef®; GlaxoSmithKline, Brentford, UK) was injected (0.1 ml of on-site prepared cefuroxime solution 10 mg/ml) in the AC, and additionally 0.5 ml cefuroxime solution 250 mg/ml was injected subconjunctivally, the volume divided in three and given in the vicinity of each sclerotomy at the end of the surgery. Topical dexamethasone (Isopto-Maxidex®; Alcon) and cyclopentholate 1% (Cyclogyl®; Alcon-Couvreur, Puurs, Belgium) was used 3–4 weeks postoperatively.

Data analysis

Primary outcome measures were divided into intraoperative and postoperative. Intraoperative measures included: leakage from AC, need to inject balanced salt solution to AC, IOL displacement to AC, communication between AC and PC, retinal break, use of triamcinolone, MB, ILM-blue, endolaser, cryo, SF_6 gas, air, and the need for scleral suture. Postoperative measures included: change in IOP; hypotony (<7 mmHg); hyphema; fibrin in AC; iris synechiae; IOL capture or decentration; posterior capsule opacification (PCO); choroidal/retinal detachment, and vitreous haemorrhage.

Secondary outcome measures were visual acuity; postoperative refraction and surgically induced astigmatism (SIA). Visual acuity was measured using the standard Snellen method and was converted to logMAR values for statistical analysis. The achieved postoperative refraction was expressed as a spherical equivalent. The postoperative refraction outcome measure was obtained by subtracting achieved postoperative refraction from the predicted refraction. We evaluated astigmatism using the polar method proposed by Naeser (2008): Any pair of polar values separated by an arc of 45 [e.g. KP (90) and KP (135) or KP (120) and KP (165)] indicates the presence of net astigmatism. The following equations were used:

$$\mathrm{KP}\,(\phi) = M \cdot [\sin^2((\alpha+90)-\phi) - \cos^2((\alpha+90)-\phi)]$$

$$\mathrm{KP}\,(\phi+45) = M \cdot [\sin^2((\alpha+90) - (\phi+45)) - \cos^2((\alpha + 90) - (\phi+45))]$$

$$\text{SIA expressed as } \Delta\,\mathrm{KP}\,(\phi) = \mathrm{KP}\,(\phi)_{\mathrm{postop}} - \mathrm{KP}\,(\phi)_{\mathrm{preop}}$$

$$\text{SIA expressed as } \Delta\,\mathrm{KP}\,(\phi+45) = \mathrm{KP}\,(\phi+45)_{\mathrm{postop}} - \mathrm{KP}\,(\phi+45)_{\mathrm{preop}}$$

KP (ϕ) = Naeser's polar value along the axis of the incision; M = magnitude of the net astigmatism (diopters, D), taken from keratometry; α = direction of the steepest meridian (degrees); and SIA = surgically-induced astigmatism.

In this setting, a positive ΔKP (ϕ) indicates a steepening of the meridian in which the incision was made. A negative ΔKP (ϕ) indicates flattening of the meridian in which the incision was made. A positive ΔKP (ϕ + 45) indicates induced anticlockwise torque, while a negative Δ KP (ϕ + 45) indicates induced clockwise torque (Naeser 2008).

Statistical analysis

Categorical variables were compared using Fisher's exact test. Analysis of variance test or *t*-test was used for comparison of continuous variables between the groups. $p < 0.05$ was considered statistically significant.

Results

Preoperative data

Thirty eyes with MH, EM and VMT were included and there was a female predominance of 2:1 (Table 1). The C-MICS and SICS group were similar for sex ratio, laterality, mean age, IOP, axial length, AC depth, cataract score and VMT. The MICS group differed from the SICS group in its visual acuity (logMAR 0.50 ± 0.25 versus 0.85 ± 0.27, p = 0.001), higher number of EM (11 versus four, p = 0.03) and a lower number of MH (two versus nine, p = 0.01).

Primary outcome measures (intraoperative and postoperative findings)

Table 2 shows the intraoperative and the postoperative findings.

With respect to intraoperative findings the C-MICS and SICS groups were similar for surgery duration and complications. The average duration of surgery in C-MICS and SICS group were 68.9 ± 19.3 and 74.7 ± 18.8 min respectively (p = 0.41). The most common complications due to the cataract surgery were leakage from AC and a need to inject balanced salt solution into the AC (two eyes, 7%): one eye in each group. The most common complication during vitrectomy was retinal break (nine eyes, 30%): four eyes in the C-MICS group and five eyes in the SICS group. In six of these nine eyes with retinal breaks (67%), PVD was induced during vitrectomy. No posterior capsule rupture occurred in any group. The C-MICS group differed from the SICS group in the more frequent use of MB (13 versus six, p = 0.02) and less frequent use of gas tamponade (five versus 11, p = 0.03).

Both groups had similar postoperative outcomes. The mean follow-up for C-MICS and SICS groups were 21.7 ± 1.4 and 21.4 ± 1.2 months, respectively. The most common complication, day 1 after surgery, was fibrin in AC (three eyes, 10%): two eyes in MICS and one eye in SICS group; hyphema (one eye, 3%) in SICS group; vitreous haemorrhage (one eye, 3%) in MICS group; hypotony (<7 mmHg): one eye (7%) in both groups. At the first postoperative examination, 4–5 weeks after surgery, both hyphema and vitreous haemorrhage cleared spontaneously and there was no incidence of hypotony.

In two of the three eyes with postoperative fibrin in AC, inflammation resolved with the regular postoperative dosage of anti-inflammatory drops, without need for increased anti-inflammatory treatment of any kind. Only one eye (3%), in SICS group with fibrin in AC developed iris synechia and PCO, which required intensive anti-inflammatory treatment and yttrium-aluminum-garnet laser capsulotomy (YAG CT). This finding could be related to long operation time (104 min) and a broad intraoperative laser treatment

Table 2. Intraoperative and postoperative data (primary outcome measures).

Factor studied	Overall (*n* = 30)	Group 2 MICS (*n* = 15)	Group 2 SICS (*n* = 15)	p-value
Surgery time (min)	71.8 ± 18.9	68.9 ± 19.3	74.7 ± 18.8	0.41
Intraoperative findings (%)				
Leakage from AC	2 (7)	1 (7)	1 (7)	
Need to inject BSS to AC	2 (7)	1 (7)	1 (7)	
IOL displacement to AC	0	0	0	
PCR	0	0	0	
Retinal break	9 (30)	4 (27)	5 (33)	0.71
Triamcinolone	15 (50)	7 (47)	8 (53)	1
MembraneBlue-Dual®	19 (63)	13 (87)	6 (40)	0.02
ILM-Blue®	15 (50)	5 (33)	10 (67)	0.08
Endolaser	11 (73)	6 (40)	5 (33)	0.72
Kryo	1 (3)	1 (7)	0	1
Gas SF_6	16 (53)	5 (33)	11 (73)	0.03
Air	14 (47)	10 (67)	4 (27)	0.065
Scleral suture	0	0	0	
Postoperative findings day 1				
IOP (mmHg)	14.9 ± 8	14.9 ± 7.7	14.9 ± 8.6	
Fibrin in AC (%)	3 (10)	2 (13)	1 (7)	1
Hyphema (%)	1 (3)	0	1 (7)	0.61
VH (%)	1 (3)	1 (7)	0	1
Hypotony (<7 mmHg) (%)	2 (7)	1 (7)	1 (7)	1
IOL capture or decentration	0	0	0	
Postoperative findings 4–5 week				
IOP (mmHg)	11.6 ± 2.5	12.5 ± 2.9	10.7 ± 1.7	0.051
Iris synechia (%)	1 (3)	0	1 (7)	1
PCO requiring Nd:YAG CT (%)	1 (3)	1 (7)	0	1
Retinal/Choroidal detachment	0	0	0	
IOL capture or decentration	0	0	0	
	(*n* = 28)	(*n* = 14)	(*n* = 14)	
Postoperative findings > 12 months				
Last follow-up (months)	21.5 ± 4.9	21.7 ± 1.4	21.36 ± 1.2	0.85
IOP (mmHg)	11.8 ± 2.9	12.8 ± 3.4	10.9 ± 1.9	0.07
PCO requiring Nd:YAG CT (%)	22 (79)	13 (93)	9 (64)	0.16
Retinal/choroidal detachment (%)	1 (4)	1 (7)	0	1
IOL capture or decentration	0	0	0	

MICS = micro-incision cataract surgery, SICS = standard incision cataract surgery, AC = anterior chamber, BSS = balanced salt solution, IOL = intraocular lens, PCR = posterior capsular rupture, MB = Membrane Blue, ILM = internal limiting membrane, SF_6 = sulphur hexafluoride, IOP = intraocular pressure, VH = vitreous hemorrhage, PCO = posterior capsular opacification, Nd:YAG CT = neodymium yttrium-aluminum-garnet laser capsulotomy.

due to many peripheral breaks during surgery.

No IOL capture or decentration was noticed during follow-up. Posterior capsule opacification, which required Nd: YAG laser capsulotomy, was observed in 22 eyes, 13 in the C-MICS group (93%) versus nine in the SICS group (64%), (p = 0.16). One eye in the C-MICS group (4%) developed retinal detachment with PVR Grade C, 2 months after surgery. The eye was successfully treated with vitrectomy and silicon oil tamponade. On average, the IOP was slightly lower in the SICS group at both 4–5 weeks and at final follow-up (12.5 versus 10.7 and 12.8 versus 10.9, respectively), but the difference did not reach statistical significance (p = 0.051 and 0.07, respectively).

Secondary outcome measures

Table 3 shows the logMAR visual acuity, refractive error and SIA.

Visual acuity improved significantly in the C-MICS group (mean ± SD, 0.17 ± 0.2, p = 0.002) and in the SICS group (0.24 ± 0.22, p < 0.001) at final follow-up. An overall myopic shift of −0.63 ± 0.7 D (all eyes) was noted and the refractive error was similar (−0.59 ± 0.8 D versus −0.65 ± 0.6 D, p = 0.81) in both groups.

Both groups showed a decrease in ΔKP (ϕ) 4–5 weeks after surgery and the flattening of the meridian in which the incision was made was larger in the SICS group [ΔKP (ϕ) −0.141 ± 0.21 for 2.75 mm versus −0.019 ± 0.09 for 1.8 mm; p = 0.0038]. However, at last follow-up, the amount of SIA decreased in both groups and the difference was not significant [ΔKP (ϕ) −0.057 ± 0.12 for 2.75 mm versus 0.0005 ± 0.16 for 1.8 mm; p = 0.38]. Both groups showed induced clockwise torque ΔKP (ϕ + 45) 4–5 weeks after surgery [ΔKP (ϕ + 45) −0.627 ± 0.23 for 2.75 mm versus −0.452 ± 0.24 for 1.8 mm; p = 0.8]. In both groups, the magnitude of induced clockwise torque was reduced at final follow-up [ΔKP (ϕ + 45) 0.082 ± 0.24 for 2.75 mm versus −0.132 ± 0.19 for 1.8 mm; p = 0.4].

Discussion

In this prospective study, C-MICS was compared with conventional standard incision phacoemulsification in combination with 23-gauge vitrectomy. The safety profile of both techniques was evaluated with respect to intraoperative and postoperative findings and SIA, refractive error and final visual acuity were compared.

The C-MICS group had a shorter mean operation time but the difference was not significant and could be associated with suturing of the cornea in the SICS group.

In terms of safety, both groups had a similar rate of complications with respect to phacoemulsification and vitrectomy. Leakage from the AC (requiring injection of balanced salt solution) occurred only in one eye (7%) of each group, despite the fact that all corneal incisions in SICS were secured with a suture. In a case series of C-MICS and vitrectomy, Jalil et al. (2014) secured the corneal incision in 11 of 52 eyes, mostly due to a learning curve and a suspected instability of the AC during subsequent vitrectomy. In the present study, none of the eyes from the C-MICS group required suturing of the corneal wound in accordance with our previous findings, which indicated that 1.8-mm corneal incision offers very good AC stability, even under excessive manipulation of the globe during surgery (Czajka et al. 2014).

Table 3. Secondary outcome measures at 4–5 weeks and >12 months after surgery.

Factor studied	Overall n = 30 at 4–5 weeks, n = 28 at >12 months	Group 1 MICS n = 15 at 4–5 weeks, n = 14 at >12 months	Group 2 SICS n = 15 at 4–5 weeks, n = 14 at >12 months	p-value
4–5 weeks				
BCVA (logMAR)	0.31 ± 0.22	0.24 ± 0.17	0.38 ± 0.25	0.08
Refractive Prediction error	−0.69 ± 0.65	−0.53 ± 0.72	−0.86 ± 0.53	0.16
SIA				
ΔKP (ϕ)	−0.081 ± 0.64	−0.019 ± 0.09	−0.141 ± 0.21	0.0038
ΔKP (ϕ + 45)	−0.540 ± 0.91	−0.452 ± 0.24	−0.627 ± 0.23	0.8
>12 months				
BCVA (logMAR)	0.19 ± 0.2	0.17 ± 0.2	0.24 ± 0.22	0.4
Refractive Prediction error	−0.63 ± 0.7	−0.59 ± 0.8	−0.68 ± 0.6	0.74
SIA				
ΔKP (ϕ)	−0.028 ± 0.55	0.0005 ± 0.16	−0.057 ± 0.12	0.36
ΔKP (ϕ + 45)	−0.025 ± 0.64	−0.132 ± 0.19	0.082 ± 0.24	0.4

MICS = micro-incision cataract surgery, SICS = standard incision cataract surgery, BCVA = best corrected visual acuity, logMAR = logarithm of minimum angle of resolution, SIA = surgically induced astigmatism, ΔKP (ϕ) = polar value in a random meridian ϕ, ΔKP (ϕ + 45) = polar value in (ϕ + 45) degrees.

Posterior capsular rupture (PCR) is an important complication during phacovitrectomy. In a similar series of 52 eyes PCR occurred in two eyes (3.8%) (Jalil et al. 2014). Lee et al. (2012) reported a 4% rate of PCR in 311 patients who underwent phacovitrectomy. There was no incidence of PCR in the present study.

The overall rate of retinal break found during surgery was nine eyes (30%) and the rate was similar in both groups: four eyes (27%) in C-MICS and five eyes (33%) in the SICS group. Here was included both iatrogenic and preexistent retinal breaks found during surgery. Although these figures seem relatively high compared with earlier published results, according to more recent studies the frequency of iatrogenic retinal breaks, when PVD is induced, can reach 32.1% and 46.3% (Chung et al. 2009; Yagi et al. 2014). Postoperative retinal detachment occurred in only one eye (4%) and this rate did not differ from similar studies (Sisk & Murray 2010; Leiderman et al. 2015).

The frequency of severe inflammation in the AC after phacovitrectomy has been reported to be between 2% and 30% (Shinoda et al. 2001; Smith et al. 2007; Kim et al. 2009; Lee et al. 2009; Li et al. 2009; Czajka et al. 2014; Jalil et al. 2014; Leiderman et al. 2015). In this study, on postoperative day 1, two eyes (13%) in the C-MICS versus one eye (7%) in the SICS group developed fibrin in the AC. It should be noted that in both C-MICS eyes the fibrinous postoperative inflammation noted at day 1 subsided with no need to change the routinely administered postoperative anti-inflammatory treatment. Although the total observed rate of fibrin formation was higher than in two previous studies of C-MICS and vitrectomy (2% and 4%), comparison should be made with caution because of the retrospective nature of those studies (Czajka et al. 2014; Jalil et al. 2014). Factors promoting postoperative synechiae after phacovitrectomy may include uveitis, proliferative diabetic retinopathy, retinal detachment, long-acting gas C_3F_8 or silicone oil (Shinoda et al. 2001; Smith et al. 2007; Kim et al. 2009; Lee et al. 2009; Li et al. 2009). Only one eye in this study (3%) developed iris posterior synechiae postoperatively, similar to previous studies of combined C-MICS and vitrectomy with low incidence (Czajka et al. 2014; Jalil et al. 2014). This may be due to the very stable AC during vitrectomy. On the other hand, none of the patients in this study were operated for retinal detachment or proliferative diabetic retinopathy and only air or SF6 gas were used as a tamponade.

Phacovitrectomy with the use of standard corneal incision can be associated with higher risk of IOL decentration or IOL capture (Chaudhry et al. 2003; Kim et al. 2009; Li et al. 2009; Nam et al. 2010). No such complications were found in the current study or in previous studies of combined C-MICS and vitrectomy (Czajka et al. 2014; Jalil et al. 2014). As previously described, this finding could be related to the 1.8 mm corneal incision and the 4-point fixation design of the Akreos MI60 IOL.

Twenty-two study eyes (78%, 11 in each group) developed PCO, which required YAG laser capsulotomy. The high incidence, when compared to other studies may be related to the long follow-up and the use of hydrophilic acrylic IOLs, which are associated with a higher rate of PCO after ordinary phacoemulsification (Sood et al. 2009; Heath & Rahman 2010; Johansson 2010; Nam et al. 2010; Sisk & Murray 2010; Hikichi et al. 2011; Rahman et al. 2011; Iwase et al. 2012). Additionally micro incision cataract surgery alone has been associated with high incidence of PCO (Schriefl et al. 2015).

Although the groups differed with regard to indications for surgery, the outcomes of combined 23-gauge vitrectomy and C-MICS or SICS in terms of visual acuity were very satisfactory in the present study, and there was no significant difference between groups.

The refractive error is calculated as the postoperative spherical equivalent (SE) minus the intended SE, and a negative refractive error is called a myopic shift. Many studies have shown a shift in refraction towards myopia in eyes operated with phacovitrectomy for MH or EM (Hamoudi & La Cour 2013).

Depending on the study the myopic shift has been reported to vary between −0.05 D up to −0.79 D (Hamoudi & La Cour 2013). Many explanations for this shift have been proposed including biometry for axial length, changes in the effective lens position (ELP), type of IOL, the formula used to calculate IOL, gas tamponade, keratometry, preoperative visual acuity and type of pathology in the macula (Hamoudi &

La Cour 2013; Frings et al. 2015). Hwang and Jee (2011) suggested using a 4-haptic angulated IOL to decrease refractive error after phacovitrectomy with gas tamponade. It has been shown that partial coherence interferometry (used in the IOLMaster), which measures axial length to retinal pigment epithelium, and the modern Haigis formula, which predicts ELP, can significantly reduce refractive error (Hamoudi & La Cour 2013). In spite of using those two techniques and implanting 4-haptic IOL in the present study, we observed an overall myopic shift of -0.63 ± 0.7 and there was no significant difference between groups despite the fact that the C-MICS group contained many cases with EM and the SICS group many MH cases. Hypothetically, gas or air tamponade may play an important role for refractive error, although previous studies have shown conflicting results (Shioya et al. 1997; Patel et al. 2007; Falkner-Radler et al. 2008; Schweitzer & Garcia 2008; Manvikar et al. 2009; Hwang & Jee 2011; Sun & Choi 2011). Additionally no calculating formulas have been developed specifically for phacovitrectomy.

Many studies of astigmatic changes after cataract surgery with short follow-up have shown a trend of SIA decreasing as the smaller corneal incision size was used (Wilczynski et al. 2009; Chen et al. 2015). Chang et al. (2015) in a study of 605 eyes operated with phacoemulsification and either 2.2- or 2.75-mm incision showed only significant differences in SIA 1 week after surgery but not 3 months after surgery. There is very little information in the literature about SIA after phacovitrectomy in regard to different corneal incision size. Kim et al. (2014) showed in a retrospective study with 1 month follow-up that phacovitrectomy with 23-gauge vitrectomy and 2.2-mm micro-incision coaxial phacoemulsification induces less SIA than does 2.75-mm standard coaxial phacoemulsification. In this study, a significant difference was also observed 1 month after surgery with less SIA expressed as ΔKP (ϕ) in the C-MICS group while the final follow-up with longer than 1 year observation did not show significant changes in any group. Our results indicate that in combination with 23-gauge vitrectomy C-MICS is associated with faster corneal rehabilitation than SICS, but this may have limited clinical significance in patients with EM or MH where VA improvement might take months after surgery.

The main limitations of this study are a small sample size and limited number of indications for surgery. Nevertheless, this is to our knowledge the first prospective study of outcomes after combined C-MICS and 23-gauge vitrectomy versus standard phacoemulsification with the same gauge vitrectomy.

In summary, we report both C-MICS or SICS together with 23-gauge vitrectomy as safe and well-tolerated surgical techniques in patients with combined macular disorders and cataract. No significant difference in complication rates were found between the two methods regarding AC leakage, vitreoretinal complications and postoperative inflammatory response. In spite of intraoperative (no need to suture cornea) and early postoperative advantages of C-MICS (less astigmatism), the two techniques yielded similar long-term results with regard to refraction outcomes and visual function.

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