Complication rates of phacoemulsification and manual small-incision cataract surgery at Aravind Eye Hospital

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PURPOSE: To analyze the rate of intraoperative complications, reoperations, and endophthalmitis with phacoemulsification, manual small-incision cataract surgery (SICS), and large-incision extracapsular cataract extraction (ECCE).

SETTING: Aravind Eye Hospital, Madurai, India.

DESIGN: Retrospective cohort study.

METHODS: This study comprised consecutive cataract surgeries performed during a 12-month period. All surgical complications and endophthalmitis cases were tabulated and analyzed for each of 4 surgeon groups (staff, fellows, residents, visiting trainees). Within each surgeon group, complication rates with phacoemulsification, manual SICS, and ECCE were compared.

RESULTS: The surgical distribution was 20 438 (26%) phacoemulsification, 53 603 (67%) manual SICS, and 5736 (7%) ECCE. The overall intraoperative complication rate was 0.79% for staff, 1.19% for fellows, 2.06% for residents, and 5% for visiting trainees. Extracapsular cataract extraction had the highest overall rate of surgical complications (2.6%). The overall complication rate was 1.01% for manual SICS and 1.11% for phacoemulsification. However, the combined complication rate for trainees was significantly higher with phacoemulsification (4.8%) than with manual SICS (1.46%) ($P<.001$). The corrected distance visual acuity was better than 6/12 in 96% after phacoemulsification complications and 89% after manual SICS complications ($P<.001$). There were 27 cases (0.04%) of endophthalmitis but no statistical differences between surgical methods or surgeon groups.

CONCLUSIONS: For staff surgeons experienced with both phacoemulsification and manual SICS, intraoperative complication rates were comparably low. However, for trainee surgeons, the complication rate was significantly higher with phacoemulsification, suggesting that manual SICS may be a safer initial procedure to learn for inexperienced cataract surgeons in the developing world.

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Although phacoemulsification is the preferred cataract surgical technique worldwide, a less expensive method is gaining popularity in the developing world where a growing backlog of cataract blindness has resulted from insufficient health-care resources.[1–3] With sutureless manual small-incision cataract surgery (SICS), the undivided nucleus is extracted and a poly(methyl methacrylate) (PMMA) intraocular lens (IOL) is implanted through a self-sealing scleral pocket incision. This technique is less expensive in terms of capital equipment investment, equipment maintenance, and disposable costs per case.[4,5] In addition, it may be faster and better suited for the advanced and mature cataracts that typify underserved populations.

The Aravind Eye Hospital system is a network of 5 regional eye hospitals in Southern India. Because we serve a very large poor population in southern India, 70% of the approximately 200 000 cataract surgeries annually performed at the Aravind Eye Hospital are free of charge or at a significantly reduced fee. To reduce the cost per case, most charitable cases are

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performed with manual SICS using a high-volume approach that has been previously reported.[6] In general, paying patients have phacoemulsification with a foldable IOL. Less commonly, sutured large-incision extracapsular cataract extraction (ECCE) is performed at the surgeon's discretion in cases deemed too risky or difficult for either of the 2 smaller incision methods. Aravind Eye Hospital is also a busy academic teaching institution with residents, fellows, and visiting surgeons being trained in all 3 methods of cataract surgery. Trainees must first learn large-incision ECCE followed by manual SICS before they are taught phacoemulsification.

Outcomes of manual SICS have been reported in numerous studies, including several from the Aravind Eye Hospital.[6,7] However, studies have directly compared the outcomes and safety of manual SICS and phacoemulsification, and these had small study populations.[8,9] We therefore sought to retrospectively analyze these 2 procedures with respect to the rate of intraoperative complications, reoperations, and endophthalmitis in a large population of consecutive cataract surgical patients from a single eye hospital (Madurai Aravind Eye Hospital). The primary question was whether 1 procedure has a lower complication rate than the other when performed by surgeons experienced in both techniques. A second but equally important question was whether 1 procedure is safer in the hands of less experienced surgeons, such as trainees.

PATIENTS AND METHODS

Surgical Technique

Phacoemulsification, large-incision sutured ECCE, and manual SICS were all performed under topical or local retrobulbar anesthesia. Manual SICS was performed through a 6.5 to 7.0 mm temporal or superior sclerocorneal tunnel. A large capsulorhexis (6.0 to 7.0 mm) was performed followed by hydrodissection. The nucleus was prolapsed into the anterior chamber using a Sinskey hook and extracted in 1 piece using an irrigating vectis. Cortical cleanup was performed with a Simcoe cannula. After implantation of a 6.0 mm diameter optic PMMA IOL, the anterior chamber was pressurized; the wound was left unsutured in most cases.

Phacoemulsification was performed using a divide-and-conquer, stop-and-chop, or direct chop technique depending on the surgeon's preference. Transitioning surgeons are first taught the divide-and-conquer method. Cortical cleanup was performed with automated irrigation/aspiration. Foldable hydrophilic or hydrophobic IOLs were implanted in the capsular bag after phacoemulsification.

Surgeon Classification

At the Aravind Eye Hospital System, ophthalmic surgeons are classified into 4 groups: full-time staff, fellows, residents, or visiting trainees. Aravind staff surgeons are fully trained in all 3 cataract surgical techniques. Fellows are enrolled in post-residency surgical training lasting 1.5 to 2.0 years. The visiting trainees are practicing ophthalmologists from other centers who enrolled in surgical skill transfer programs at Aravind lasting 1 to 3 months. Residents are required to complete approximately 40 large-incision ECCE procedures before initiating their training in manual SICS. The residents perform phacoemulsification during the last 3 months of their training, and the fellows start phacoemulsification in the second year of their training.

Data Collection and Quality Assurance

Aravind Eye Hospital has developed an electronic medical records system that records operative and postoperative data from every cataract surgery. This includes intraoperative complications (including the operative step involved) and early or late postoperative complications (including reoperations). For analysis and reporting in this study, corrected distance visual acuity (CDVA) was grouped into 3 categories (6/12 or better, worse than 6/12 but 6/60 or better, and worse than 6/60). Patients with other preoperative vision-impairing pathology were excluded from the analysis.

Combined procedures (cataract with penetrating keratoplasty, trabeculectomy, or strabismus surgery), traumatic cataract, posterior polar cataract, known cases of severe zonular dehiscence, and pediatric patients (younger than 15 years) were excluded from the study. All other cataract surgeries were reviewed for untoward events. Endophthalmitis was diagnosed based on the examining staff ophthalmologist's clinical judgment and culture results. Any cases diagnosed by trainees required confirmatory examination by a staff ophthalmologist.

Major intraoperative complications were defined as posterior capsule rupture with or without vitreous loss, zonular dehiscence with or without vitreous loss, retained lens fragment, IOL dislocation, inability to implant an IOL, iridodialysis larger than 3 clock hours, Descemet membrane detachment of at least one third of the total corneal area, and suprachoroidal expulsive hemorrhage.

Statistical Analysis

Categorical variable are expressed as frequency (percentage). Multiple logistic regression analysis was performed to find the factors associated with the surgical complication. A P value less than 0.05 was considered statistically

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Table 1. Overall rate of intraoperative complications by cataract surgery method.

Technique	Surgeries	Intraop Complications, n (%)
Phaco	20 438	227 (1.11)
M-SICS	53 603	544 (1.01)
ECCE	5736	149 (2.60)
Total	79 777	920 (1.15)

ECCE = extracapsular cataract extraction; M-SICS = manual small-incision cataract surgery; Phaco = phacoemulsification

significant. All analyses were performed using Stata software (version 11.0, Stata Corp LP.).

RESULTS

Of the 234 ophthalmologists performing cataract surgery during the study period, there were 83 residents and 38 full-time staff surgeons. There were 46 fellows and 67 visiting trainees.

During the 1-year study period from December 2008 to December 2009, 79 777 consecutive patients had cataract surgery at Aravind Eye Hospital. Phacoemulsification was done in 20 438 cases (26%), manual SICS in 53 603 cases (67%), and planned large-incision ECCE in 5736 cases (7%).

Table 1 shows the number of intraoperative complications for each of the 3 surgical techniques. The total intraoperative complication rate was 1.15% (920 of 79 777). The large-incision ECCE technique had the highest rate of intraoperative complications.

Table 2 shows the intraoperative complication rate for each of the 3 surgical techniques by the 4 surgeon categories. For all 3 techniques in aggregate, compared with staff surgeons, the visiting trainees, residents, and fellows were more likely to have complications, an odds ratio (OR) of 6.62 (95% confidence interval [CI], 5.05-8.67), 2.65 (95% CI, 2.27-3.08), and 1.52 (95% CI, 1.24-1.85), respectively.

Approximately half of the 5736 total ECCE cases were performed by residents and visiting trainees, who also had the highest rates of intraoperative complications (Table 2). Because ECCE accounted for only 7% of the total surgical volume and was disproportionately performed by the least experienced surgeons, all further data analysis was confined to comparing phacoemulsification and manual SICS complications in the remaining 74 041 patients.

Table 3 shows the results of univariate analysis to analyze several potential risk factors for intraoperative complications. There was no statistically significant difference in the complication rate when comparing age (older or younger than 60 years), sex, payment status (private versus charity), or type of surgery (phacoemulsification versus manual SICS). However, each trainee category and the aggregate of all trainees had a significantly higher rate of operative complications than staff surgeons (OR, 2.08; $P < .001$).

Table 4 shows the results of the multivariate analysis that included surgery type, surgeon designation, and the interaction of these 2 variables. Compared with staff surgeons, every trainee group had a higher risk for surgical complications when performing phacoemulsification (OR, 5.57; $P < .001$) or manual SICS (OR, 2.06; $P < .001$). Manual SICS had a lower risk for complications than phacoemulsification among staff surgeons (OR, 0.79, $P = .019$) and the aggregate group of all trainee surgeons (OR, 0.29, $P < .001$).

When each of the individual trainee groups were compared (fellows, residents, and visiting trainees), there was a statistically higher complication rate with phacoemulsification than with manual SICS. The difference in risk between the 2 methods was greatest and highly significant for the least experienced surgeons (residents and visiting trainees).

Because Table 2 clearly established a higher risk for complications among less experienced surgeons, fellows, residents, and visiting trainees were grouped together to analyze which types of complications were more common with phacoemulsification or with

Table 2. Intraoperative complication rate comparison between different surgeon groups by surgical technique.

Surgeon Category	Total Surgical Volume	Intraoperative Complication Rate, n (%)			
		Phaco	M-SICS	ECCE	Overall
Staff	52 274	174 (0.90)	225 (0.71)	13 (1.03)	412 (0.79)
Fellow	11 324	15 (2.06)*	85 (0.94)*	35 (2.30)*	135 (1.19)*
Resident	14 818	10 (8.20)*	216 (1.75)*	79 (3.39)*	305 (2.06)*
Visiting trainee	1361	28 (11.20)*	18 (3.68)*	22 (3.54)*	68 (5.00)*
Overall	79 777	227 (1.11)	544 (1.01)	149 (2.60)	920 (1.15)

ECCE = extracapsular cataract extraction; M-SICS = manual small-incision cataract surgery; Phaco = phacoemulsification
*$P < .05$ compared with the staff complication rate for the respective procedure

Table 3. Factors associated with surgical complications (univariate analysis).

Variable	Total (n)	Intraop Complications (n)	Univariate Analysis		
			OR	95% CI	*P* Value
Age (y)					
≤59	30 348	299	1.00	—	—
>59	43 693	472	1.10	0.95, 1.27	.21
Sex					
Male*	35 323	379	1.00	—	—
Female	38 718	392	0.94	0.82, 1.09	.418
Type of patient					
Private (paying)*	25 721	260	1.00	—	—
Charity	48 320	511	1.05	0.90, 1.22	.551
Type of surgery					
Phaco*	20 438	227	1.00	—	—
M-SICS	53 603	544	0.91	0.78, 1.07	.250
Surgeon designation					
Staff*	51 011	399	1.00	—	—
Fellow	9802	100	1.31	1.05, 1.63	.017
Resident	12 489	226	2.34	1.98, 2.76	<.001
Visiting trainee	739	46	8.42	6.15, 11.53	<.001
Surgeon designation					
Staff*	51 011	399	1.00	—	—
All Trainees	23 030	372	2.08	1.81, 2.40	<.001

CI = confidence interval; M-SICS = manual small-incision cataract surgery; OR = odds ratio; Phaco = phacoemulsification
*Reference group for comparison

manual SICS. Table 5 compares the rates of different intraoperative complications between phacoemulsification and manual SICS. The staff and all trainee surgeon groups were analyzed separately. Overall, posterior capsule rupture was the most frequent complication accounting for two thirds (519 of 771 eyes, 67%) of all complications. Vitreous loss occurred in 374 of 519 (72%) of these eyes. The overall posterior capsule rupture or vitreous loss rate was 0.87% for phacoemulsification and 0.64% for manual SICS. For both the staff and all trainee surgeon groups, there was a statistically higher rate of posterior capsule rupture with or without vitreous loss during phacoemulsification than during manual SICS. This difference was highly significant among the trainee surgeons.

Table 4. Factors associated with surgical complications (multivariate analysis).

Variable	Multivariate Analysis		
	OR	95% CI	*P* Value
Type of surgery			
Phaco*	1.00	—	—
M-SICS	0.79	0.65, 0.96	.019
Surgeon designation			
Staff*	1.00	—	—
All trainees	5.57	4.07, 7.62	<.001
Type of surgery/surgeon designation	0.37	0.26, 0.53	<.001

CI = confidence interval; M-SICS = manual small-incision cataract surgery; OR = odds ratio; Phaco = phacoemulsification
*Reference group for comparison

The next most common complication was zonular dialysis; however, there was no statistically significant difference between phacoemulsification and manual SICS for either surgeon group. Certain complications, however, were much more likely to occur with one type of procedure. Sixty-seven eyes (0.1%) were left aphakic because of insufficient capsule support. All but 1 of these cases occurred with manual SICS. Iridodialysis was rare, but occurred statistically more often with manual SICS in both surgeon groups. On the other hand, the rate of dropped nucleus was statistically significantly higher with phacoemulsification than with manual SICS in both surgeon groups ($P < .001$).

In 23 eyes, posterior capsule rupture was missed or not documented during surgery and was noted only postoperatively. With the manual SICS technique, irrespective of surgeon experience, complications were equally likely to occur during the nucleus removal and cortex aspiration steps. For all trainee surgeons performing phacoemulsification, complications were

Table 5. Comparison of phacoemulsification and manual SICS rates for specific complications (analyzed separately for staff and all trainee surgeons).

	Staff			
	Number (%)			
Intraoperative Complication	Both Techniques (n = 51 011)	Phaco (n = 19 337)	M-SICS (n = 31 674)	*P* Value
Descemet membrane detachment	3 (0.01)	0	3 (0.01)	.294
Iridodialysis	10 (0.02)	0	10 (0.03)	.017
PCR (with vitreous loss)	189 (0.37)	75 (0.34)	114 (0.36)	.614
PCR (without vitreous loss)	96 (0.12)	51 (0.26)	45 (0.14)	.002
Zonular dialysis (+/− vitreous loss)	53 (0.10)	26 (0.13)	27 (0.09)	.094
Dropped nucleus	23 (0.05)	18 (0.09)	5 (0.02)	<.001
Dropped IOL	5 (0.01)	3 (0.02)	2 (0.01)	.374
Inability to implant IOL	17 (0.03)	1 (0.01)	16 (0.05)	.006
Suprachoroidal hemorrhage	3 (0.01)	0	3 (0.01)	.294
Total	399 (0.80)	174 (0.89)	225 (0.70)	.018

IOL = intraocular lens; M-SICS = manual small-incision cataract surgery; PCR = posterior capsule rupture; Phaco = phacoemulsification
*Fellow + resident + visiting trainee
†Comparison between phaco and M-SICS for all surgeons (χ^2 test/Fisher exact test)

much more common during nucleus removal. For staff phacoemulsification, complications were evenly distributed between the nucleus removal and cortex aspiration steps (Table 6 and Figure 1).

Table 7 shows the 1-month corrected visual outcomes in all patients with an intraoperative complication. Based on the percentage of patients achieving 6/12 or better CDVA, the overall outcomes were statistically better with phacoemulsification (96%) than with manual SICS (89%) ($P<.001$). Overall, 91% had a final CDVA of 6/12 or better.

Of the 74 041 consecutive cataract surgeries performed, 27 cases (0.04%) were diagnosed with postoperative infectious endophthalmitis (Table 8). There was no statistically significant difference between phacoemulsification and manual SICS or between the staff or trainee surgeons. Of 27 endophthalmitis cases diagnosed, 59% were culture positive. Antecedent posterior capsule rupture had occurred in only 1 of the cases.

Among staff surgeons, manual SICS had a statistically higher rate of reoperations than phacoemulsification ($P=.002$), whereas there was no significant difference among all trainee surgeons ($P=.278$). Combining all 3 techniques, visiting trainees, residents, and fellows had a statistically higher rate of reoperations

Table 6. Comparison of staff and all trainee surgeons with respect to the surgical steps at which complications occurred for the 2 techniques.

	Number (%)					
	Phaco (n = 227)			M-SICS (n = 544)		
Surgical Step	Staff (n = 174)	All Trainees* (n = 53)	All Surgeons (n = 227)	Staff (n = 25)	All Trainees* (n = 319)	All Surgeons (n = 544)
Nucleus disassembly	6 (3.5)	2 (3.8)	8 (3.5)	NA	NA	NA
Quadrant emulsification	81 (47.0)	41 (77.0)	122 (54.0)	NA	NA	NA
Nuclear prolapse	NA	NA	NA	9 (4.0)	29 (9.0)	38 (7.0)
Nucleus extraction	NA	NA	NA	88 (39.0)	99 (31.0)	187 (34.0)
Cortex aspiration	56 (32.0)	5 (9.5)	61 (26.9)	86 (38.0)	130 (41.0)	216 (40.0)
IOL implantation/positioning	22 (12.6)	5 (9.5)	27 (11.9)	28 (12.0)	41 (13.0)	69 (13.0)
Other steps	9 (5.2)	NA	9 (3.9)	14 (6.2)	20 (6.3)	34 (6.3)
Total	174 (77.0)	53 (23.0)	227	225 (41.0)	319 (59.0)	544

IOL = intraocular lens; M-SICS = manual small-incision cataract surgery; NA = not applicable; Phaco = phacoemulsification
*Fellow + resident + visiting trainee

Table 5. (Cont.)

All Trainees*					
Number (%)					
Both Techniques (n = 23 030)	Phaco (n = 1101)	M-SICS (n = 21 929)	*P* Value	All Surgeons (n = 74 041) Number (%)	*P* Value†
5 (0.02)	0	5 (0.02)	1	8 (0.01)	.117
17 (0.07)	0	17 (0.08)	1	27 (0.04)	.001
189 (0.82)	42 (3.80)	147 (0.67)	<.001	378 (0.51)	.144
45 (0.12)	9 (0.80)	36 (0.16)	<.001	141 (0.19)	<.001
58 (0.25)	0	58 (0.26)	.116	111 (0.15)	.324
4 (0.02)	2 (0.18)	2 (0.01)	.013	27 (0.04)	<.001
2 (0.01)	0	2 (0.01)	1	7 (0.01)	.404
50 (0.22)	0	50 (0.23)	.176	67 (0.09)	<.001
2 (0.01)	0	2 (0.01)	1	5 (0.01)	.332
372 (1.60)	53 (4.80)	319 (1.46)	<.001	771 (1.00)	.251

than staff ($P<.001$), with ORs of 2.45 (95% CI, 1.30-4.52), 2.48 (95% CI, 1.97-3.11), and 1.39 (95% CI, 1.02-1.89), respectively.

DISCUSSION

In large part because of cost, manual SICS is becoming an increasingly popular technique in the developing world.[1,3,6,10,11] Although several outcome studies support the general safety and efficacy of this approach,[6–9,12] phacoemulsification remains the preferred method in developed countries. We believe that ours is the first study to report the complication rates of the 2 methods in a large series of consecutive cataract surgeries performed at a single institution. We also believe that this is one of the largest series of cataract surgeries from a single institution to be evaluated for the rate of intraoperative complications, infectious endophthalmitis, and reoperations. This was made possible by the high volume of cataract surgery performed at our hospital, by our electronic medical record system that routinely and specifically captures data on complications, and because both surgical methods are regularly used at our institution.

Our overall rates of endophthalmitis (0.04%), intraoperative complications (1.15%), and posterior capsule rupture with vitreous loss (0.51%) compare favorably with those in other series in the literature. Between 2005 and 2009, the rate of vitreous loss in published nonresident series numbering at least 1000 cases ranged from 1.1% to 2.7%.[13–17] The rate in published resident series during this period ranged

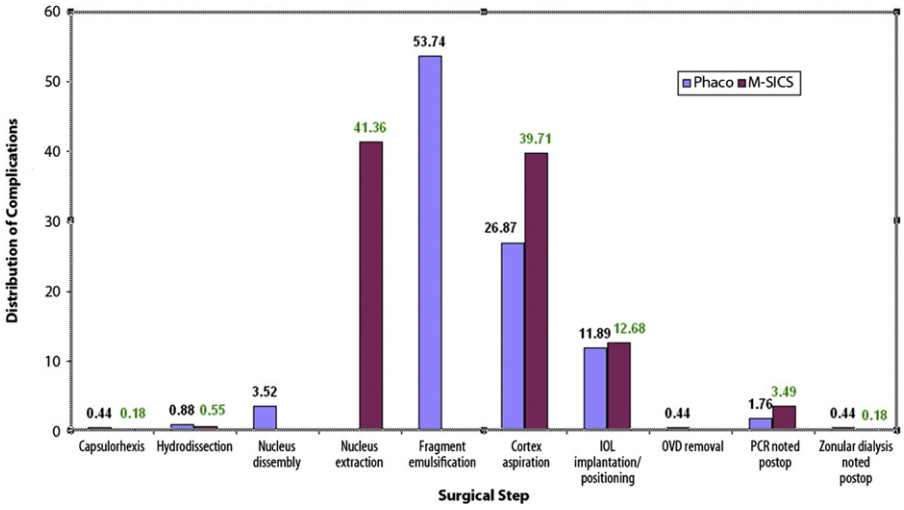

Figure 1. Analysis of the surgical steps at which complications occurred for both phacoemulsification and manual SICS (IOL = intraocular lens; M-SICS = manual small-incision cataract surgery; OVD = ophthalmic viscosurgical device; PCR = posterior capsule rupture; Phaco = phacoemulsification).

Table 7. Comparison of visual outcomes after complications associated with the 2 surgical methods.

	Number			1 Mo Postop CDVA*					
				6/12 or Better		<6/12 but ≥6/60		<6/60	
Method	Intraop Complications	Lose to FU	Preop Pathology	Staff	All Trainees†	Staff	All Trainees†	Staff	All Trainees†
Phaco	227	8	5	160 (97.0)	46 (94.0)	4 (2.4)	3 (6.0)	1 (0.6)	NA
M-SICS	544	52	12	166 (90.0)	260 (88.0)	15 (8.0)	31 (11.0)	4 (2.0)	4 (1.0)
Total	771	60	17	326 (93.0)	306 (89.0)	19 (5.4)	34 (10.0)	5 (1.4)	4 (1.0)

CDVA = corrected distance visual acuity; FU = follow-up; M-SICS = manual small-incision cataract surgery; NA = not applicable; Phaco = phacoemulsification
*Excluding preop pathology
†Fellow + resident + visiting trainee

from 1.3% to 6.1%.[18–25] More recently, the 3 largest multicenter series to evaluate the rate of vitreous loss were published. The Cataract National Dataset audit of 55 567 operations from the United Kingdom reports a 1.9% rate of vitreous loss in 2009.[26] A 2.1% vitreous loss rate was reported during an 8-year period from the Swedish National Cataract database.[27] Similarly, Greenberg et al.[28] report a vitreous loss rate of 3.5% in 45 082 United States Veterans Administration Hospital cataract surgeries. It is assumed that resident surgeons performed a significant number of these cases.

The endophthalmitis rate and the overall complication rate were very low for both phacoemulsification and manual SICS in our series. Specifically, the overall posterior capsule rupture or vitreous loss rate was low for phacoemulsification (0.87%) and for manual SICS (0.64%). There are little comparative data on complication rates of phacoemulsification and manual SICS in the literature. Of these, there are only 2 prospective randomized trials; however, both enrolled very small numbers of patients.[8,9] Neither study found a statistical difference in posterior capsule rupture or vitreous loss between the 2 surgical methods.

Data analysis is complicated by the fact that surgeons of varying experience operate at any large teaching hospital such as ours. Combining all techniques at our institution, the rate of intraoperative complications increased with decreasing surgical experience (0.79% for staff, 1.19% for fellows, 2.06% for residents, 5.00% for visiting trainees). This expected trend has been reported by others.[15,29] In the large U.K.-based series, for example, posterior capsule rupture occurred in 1.41% of cases performed by independent surgeons, 2.48% performed by senior trainees, and 5.10% performed by junior trainees.[29] We therefore analyzed complication rates for phacoemulsification and for manual SICS separately for staff surgeons and for all trainee surgeons.

The procedure method was not randomized in our study, and there were important differences in the indications and patient populations for each surgical method. For example, the ECCE group typically represented the earliest cases of all trainee surgeons[30] and the most difficult cases for the staff surgeons. We believe that this adverse case selection bias explains the higher complication rate with large-incision manual ECCE for both staff and all trainee surgeons.

Staff surgeons performed 19 337 phacoemulsification and 31 674 manual SICS procedures. Among staff surgeon cases, the majority of charity eye patients received the less costly manual SICS method, while phacoemulsification was the most common method

Table 8. Rate of endophthalmitis according to type of surgery and surgeon experience.

		Phaco		M-SICS	
Surgeon	Surgeons (n)	Surgeries (n)	Infection, n (%)	Surgeries (n)	Infection, n (%)
Staff	38	19 337	11 (0.06)	31 674	7 (0.02)
Fellows	46	729	0	9073	1 (0.01)
Residents	83	122	0	12 367	6 (0.05)
Visiting trainee	67	250	0	489	2 (0.41)
Total	234	20 438	11 (0.05)	53 603	16 (0.03)

M-SICS = manual small-incision cataract surgery; Phaco = phacoemulsification

used for paying patients. We recognize that these socioeconomic policies may introduce confounding factors into the analyses. For example, one might expect poor charity patients to have had more advanced and mature cataracts than private paying patients. In addition, staff surgeons tend to elect manual SICS for the most advanced or complicated cataracts in private pay patients. For these reasons, a statistical comparison of staff surgeon complication rates for each of the 2 techniques might not be valid. One would predict that these factors might have predisposed the manual SICS group to a higher complication rate than if the procedure choice had been randomized. Among staff surgeons, however, both procedures had total complication rates below 1%. Because our staff surgeons are equally adept with both techniques, these data support the comparable safety of manual SICS and phacoemulsification when performed by experienced surgeons.

Because of the severe shortage of ophthalmologists in the developing world, there is a pressing need to train many more cataract surgeons to decrease the backlog of cataract blindness. The lack of traditional residency training programs in so many global areas of need raises the important question of whether these new cataract surgical trainees should first be taught phacoemulsification or manual SICS. We believed that it would be useful and valid to statistically compare complication rates for phacoemulsification versus manual SICS for each of the 3 trainee surgeon groups.

At our institution, we follow a stepwise training progression whereby sufficient experience with large-incision ECCE precedes learning manual SICS and phacoemulsification is taught only after competency with manual SICS (which includes capsulorhexis) is achieved. Therefore, our phacoemulsification trainees already have experience performing capsulorhexis, which is one of the most difficult steps to learn.[18]

Despite this structured and stepwise system of progression, our study shows that for all trainee surgeons, the complication rate with phacoemulsification was much higher than with manual SICS. The difference in posterior capsule rupture and vitreous loss rates was highly significant. We believe that attempting to learn phacoemulsification without first learning manual SICS would have been associated with an even higher complication rate. Finally, visiting trainees had the greatest increase in complication rates with phacoemulsification relative to manual SICS. Many of these surgeons came from developing countries and received intensive training during a short period (1 to 3 months). This further suggests that manual SICS is a safer alternative to phacoemulsification for this group of less experienced ophthalmologists.

Of all eyes having surgical complications at our hospital, 91% achieved a CDVA of 6/12 or better at the 1-month follow-up. Previous studies[16,23,31,32] that also excluded patients with preoperative pathology impairing vision have reported visual outcomes of 6/12 or better in 86% to 91% of patients with complications. Overall, only 4 manual SICS patients and 1 phacoemulsification patient experienced intraoperative complications that resulted in a CDVA worse than 6/60 at the 1-month postoperative visit. The CDVA was worse than 6/12 in 46 manual SICS patients and 7 phacoemulsification patients. Of eyes with complications having surgery performed by trainee surgeons at our hospital, 89% achieved a CDVA of 6/12 or better 1 month postoperatively. These relatively favorable outcomes may partly reflect our protocols by which an attending staff surgeon usually takes over the case once a trainee experiences a complication.

In conclusion, manual SICS has been advocated for poor populations in the developing world because of advantages in cost, speed, reduced technology and maintenance, shorter learning curve, and suitability for mature and brunescent cataracts. When comparing manual SICS and phacoemulsification in the hands of surgeons experienced with both techniques, we found no meaningful difference in the rates of surgical complications or endophthalmitis at our institution. However, the complication rates were significantly higher with phacoemulsification than with manual SICS in the hands of the least experienced surgeons (residents and visiting trainees). These findings suggest that compared with phacoemulsification, manual SICS is comparably safe for experienced surgeons but is the safer technique for less experienced cataract surgeons. The need to train large numbers of new cataract surgeons in underserved societies to stem the growing backlog of cataract blindness is yet another reason manual SICS may initially be the procedure of choice for less experienced surgeons in the developing world.

WHAT WAS KNOWN

- Manual SICS is commonly performed in the developing world because of its lower cost per case. There are no studies comparing complication rates for manual SICS and phacoemulsification in large populations of patients at a single institution.

WHAT THIS PAPER ADDS

- The complication rates for manual SICS and phacoemulsification were comparably low in the hands of experienced surgeons proficient in both techniques. However, manual SICS had a much lower surgical complication rate in the hands of trainee surgeons.

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