Journal of Surgery
2013; 1(5): 63-69
Published online December 10, 2013 (http://www.sciencepublishinggroup.com/j/js)
doi: 10.11648/j.js.20130105.11

Learning curve of a trainee ophthalmologist in manual small incision cataract surgery: A self-appraisal

Emmanuel Olu Megbelayin[1, *], Ashok Rangarajan[2], Sreedhar Pindikura[3]

[1]Department of Ophthalmology, University of Uyo Teaching Hospital, Uyo, Nigeria
[2]Ashok Rangarajan, FRCS, Sankara Eye Hospital, Sankara Nagar, Pammal, Chennai, Tamil Nadu, India
[3]Tulsi Chanrai Foundation, General Hospital, Calabar, Nigeria

Email address:

favouredolu@yahoo.com (E. O. Megbelayin), ashok_rangarajan@yahoo.com (A. Rangarajan), drsreedhar_p@yahoo.com (S. Pindikura)

To cite this article:

Emmanuel Olu Megbelayin, Ashok Rangarajan, Sreedhar Pindikura. Learning Curve of a Trainee Ophthalmologist in Manual Small Incision Cataract Surgery: A Self-Appraisal. *Journal of Surgery.* Vol. 1, No. 5, 2013, pp. 63-69. doi: 10.11648/j.js.20130105.11

Abstract: Purpose: To appraise the learning pattern in Manual Small Incision Cataract Surgery (MSICS) of a trainee ophthalmologist. Setting: Sankara Eye Hospital, Pammal, Chennai, India. Design: Retrospective study. Methods: Case files of patients who underwent MSICS during the training were reviewed. Surgical complications, nucleus density, extent of supervisors' intervention in surgeries and visual acuity were either tabulated or graphically presented. Two-way ANOVA and multiple regressions were used to compare dependent variables. Results: There were 123 eyes of 123 patients {males 49 (39.8%), females 74 (60.2%)}. The mean age was 63.19 $\pm$ 6.6 years with a range of 40-80 years. The worst post-operative visual acuity (VA) was in the first month of training. With an overall complication rate of 30.9%, posterior capsular rent (PCR) was most prevalent in eyes operated in the first month of training (3 of 18 eyes, 16.7%). Supervisors' intervention in surgeries was highest in the first month of training and declined as training progressed. Fischer's Exact test for intraoperative complications and extents of supervision showed a statistically significant (P = 0.012). Multiple logistic regression analysis showed that density of nucleus was statistically significant (P = 0.02). Conclusions: Three months appear sufficient for learning the surgical rudiments of MSICS for a trainee with a modest competence in Extra-capsular Cataract Extraction (ECCE), especially if surgeries are performed on a continuous basis during the period.

Keywords: Cataract, MSICS, Trainee Ophthalmologist, Learning Curve

1. Introduction

Manual Small Incision Cataract Surgery (MSICS) is a cataract surgical intervention with the merits of being economical and universally applicable to all grades of cataract. Phacoemulsification is machine-dependent and the costs are often prohibitive in developing countries where large volumes of surgeries have to be performed.[1-3] Again the learning curve of phacoemulsification is known to be very steep.[4-8] The economic viability and speed of surgery are twin factors that have made MSICS gain widespread adoption.[9] It is particularly found useful in eye camps and high volume cataract surgery centers.[10]

Over the years different techniques have been employed to deliver cataractous nucleus. Starting with Intracapsular cataract surgery, intracameral chemotrypsin digests zonules for the nucleus to be delivered en bloc along with the enclosing capsules. This often disrupts anterior vitreous face with attendant complications. This technique has gone into disrepute with the modifications by Extra-Capsular Cataract Extraction (ECCE) that ensures retention of posterior capsule, intact anterior vitreous face and relatively less distorted ocular anatomy and optics. Modified Blumenthal [11], phacofracture[12], viscoexpression [13], phacosandwich[14], irrigating vectis[15] and fish hook[16] techniques are some of the modalities of delivering hydro-dissected and prolapsed nuclei.

MSICS is the surgery of choice in most developing countries.[17] Many postgraduate medical training centers in Nigeria have begun mentoring ophthalmic residents in MSICS. Although many surgical manuals and videos are available on MSICS, much remains to be gained about the learning milestones of trainee MSICS surgeons. This self-appraisal is well suited to seek a deeper understanding of this important area.

2. Patients and Methods

2.1. Background to the Study

The trainee whose surgical experience is being considered had a modest skill in ECCE having performed about 40 unassisted cases. He sought for an upgrade to MSICS from Sankara Eye Hospital, Pammal, Chennai, India. The training lasted three months, 1st June to 31st August, 2012. Five surgeons experienced in MSICS were involved in the training using side view observoscope for guidance. Operation days were Mondays to Fridays except National holidays. The trainee was requested to carry out ECCE to ascertain background level of competence. In all, 123 patients had MSICS excluding the first cataract surgery which was a conventional ECCE

2.2. Preoperative Routine

It was a retrospective study. A review of surgical training log book was carried out. This included patient's age, sex, grade of cataract, pre-operative findings that could pose intra-operative challenges, intra-operative complications and visual acuity (VA) in meters. Patients were admitted a day before surgery for detailed pre-operative assessment. Clinical examinations included VA, biometry (intraocular lens power was calculated using SRK-II formula), funduscopy, slit lamp examination and internist's review when indicated. Patients with systemic diseases must be certified fit for surgery by internist. Patients having systemic diseases, poorly dilated pupils, and complicated cataracts were not operated by trainees. Preferably, trainees were to operate on patients who were 70 years and above, Lens Opacities Classification System (LOCS) II or III and those who have not had previous cataract surgery. This was to ensure maximal patient cooperation.

On the day of surgery, pupillary dilatation was achieved with 0.8% Tropicacyl (Tropicamide and Phenylephrine, Sunways Pvt, Mumbai, India). Topical ketorolac (flurbiprofen) was instilled to maintain intra-operative mydriasis. The surgery was performed with 4-6ml peri-bulbar anesthesia of Lox 2% (Xylocaine 2% and 1:200,000 adrenaline, Neon Lab Ltd, Mumbai, India) and 0.5% Anawin (bupivacaine 0.5%, Neon Lab Ltd, Mumbai, India). Hynidase (15 units/ml Hyaluronidase, Shreya Life Sciences Pvt, Aurangabad, India) was added for good tissue perfusion. This was often given by trained nurses or trainee ophthalmologists on blocking rotation. A calibrated weight was then placed on the anaesthetized eye for 5 minutes to obtain a soft globe. Microscopes used were Topcon (OMS 90) and Tagaki (OM5, Japan incorporated). The assistants were nurses specifically trained in MSICS. Consents for surgeries were obtained from each patient in standardized consent forms contained in each case file.

2.3. Surgical Technique

Surgical procedures involved a fornix-based conjunctival peritomy with Westcott's scissors. This was followed by cauterizing bleeding vessels using wet cautery. Linear scleral incision 2mm posterior to surgical limbus and about 6.5mm long (measured with Castroviejo's calipers) was made with a blade fragment (Raja industrial blade, India). Tunneling by angled tunnel blade/crescent knife (Sharpedge instruments Pvt, India) was fashioned 1mm into clear cornea and extended laterally to produce pockets on both sides. Side port was created in clear cornea at 9 o'clock. Air, then trypan blue was used to stain the anterior capsule for easier capsulorrhexis. Can-opener or Continuous curvilinear capsulorrhexis (CCC) was done with capsulotome (bent 26G X ½, 0.45mm X 13mm needle) through the side-port.

The trainee started with can-opener then later CCC. Occasionally, CCC was incomplete or peripheral extension warranted completion of capsulorrhexis with can-opener technique. Small CCC was extended by radial multiple cuts to ease nucleus prolapse. Anterior chamber (A/C) was entered with angled 45 degree 3.0mm sterilizable microkeratome at the anterior-most part of the inner tunnel already 1mm into clear cornea. With anterior and lateral movements, wound was extended into the side pockets earlier created by tunneling, giving an inverted trapezoid opening. Viscoelastic (2% methyl cellulose, Appasamy associates, Puducherry, India) was generously used whenever A/C collapsed at every stage of the surgery. Hydrodissection was done with 27-guage cannula and Ringer's lactate solution,

Viscoelastic was injected to fill A/C for easy nucleus prolapse and rotation. Nucleus delivery was by sandwich technique with a Vectis and Sinskey hook. Viscoelastic was injected above and below the nucleus to protect the endothelium, push the iris diaphragm and posterior capsule posteriorly. Vectis with surface corrugations was introduced under the dislocated lens until fully engaged in the cup of the vectis, then Sinskey hook was introduced carefully on the anterior surface of the prolapsed nucleus and guarded out while gently depressing the outer lip incision. Retained fragmented nucleus was rotated so that its long axis was perpendicular to the horizontal incision for much easier Vectis-Sinskey delivery. Visco-expression of soft lens matters including epi-nucleus was done. Left over cortical wash was with simcoe cannula. Thereafter, A/C was reformed with Viscoelastic and a 6mm diameter poly methyl-metacrylate (PMMA) intraocular lens (Appasamy Associates Pvt, Puducherry, India) implanted and dialed in place with Sinskey.

Occasionally, intracameral epitrate (0.1ml of adrenaline 1:1000 in 0.3ml Hartman's solution was used to achieve intraoperative mydriasis. Intracameral Carpinol (pilocarpine 0.5%, Sunways, Pvt, India) bolus was used in cases of floppy prolapsed iris. Conjunctiva was reposited by wet cautery. Surgical wounds were unsutured in most

cases. However, in cases of premature entries with iris prolapse or incompetent valvular system of the tunnels, variable numbers of interrupted 10/0 nylon sutures were applied by the trainee or supervisors. Stripped Descemet's membranes were tamponade in place with Intracameral air. Stromal hydration kept side port sealed.

Following completion of surgery, subconjunctival 0.2ml tobramycin 80mg/2ml mixed with 0.3ml dexamethasone 4mg/ml, intracameral 0.5ml moxifloxacin 0.5% (Vigamox 0.5%, United Biotech Pvt, India) were administered. Topical 5% Apidine (Providone iodine, Appasamy Pvt, Puducherry, India) was applied. The operated eye was then firmly padded with single layer eye patch and Cartella shield. Patients were re-admitted in the ward. First day post-operative assessments included VA and slit lamp examination. Patients with satisfactory first day post-operative conditions were discharged on topical Oflocin-Dx (Ofloxacin 0.3%, dexamethasone 0.1% combination, Microlabs Pvt, Bangalore, India). Those with corneal edema were given 5% Hypersol (Sodium Chloride, Jawa Pharm, Pvt, Jaipur, India). Pred forte 1% (Prednisolone acetate, Allergan Ltd, Mayo, Ireland) was given to patients thought to have excessive post-operative inflammations. Patients found unfit for discharge were kept for a couple of days until they were considered fit for discharge.

2.4. Data Collection and Quality Assurance

The bulk of the data analyzed in this study was extracted from the surgical log book of the trainee. Where necessary, references were made to the well-maintained Electronic Health Record (EHR) of the hospital. At every surgical training session, a supervisor was on ground to intervene whenever it became necessary. Appendix I shows Oxford Cataract Treatment and Evaluation Team (OCTET) intraoperative grading and scoring system. Appendix II is being proposed by the current study as SICS Trainee's Supervision Scores (STSS). In STSS, core SICS steps are accorded high scores in accordance with extent of supervisor's intervention. Scores are summed up in cases where two or more grades were applicable. The scoring pattern was developed to enable objective, quantitative and graphical analysis.

All cases operated by the trainee were computed and analyzed except the first case which was a conventional ECCE. Research procedures were in line with the tenets of Helsinki declaration.

2.5. Statistical Analysis

All statistical analyses were performed by Statistical Package for Social Sciences (SPSS, version 15.0, Chicago, USA). Categorical variable were expressed as frequency and percentages. Key statistical parameters were tabulated. Two-way ANOVA was used to find the association between intraoperative complications and extents of supervisors' intervention during surgeries. Multiple logistic regression analysis was performed to find the factors associated with the intraoperative complications. P-value less than 0.05 was considered statistically significant.

3. Results

The trainee carried out MSICS in 123 patients over three months: first month (18), second month (41) and third month (64). The mean age of the patients was 63.19 + 6.6 years. Other demographic details are as stated in table 1. The LOCS grades of cataract operated were: NSII (n = 77, 62.6%), NSIII (n = 23, 18.7%), NS IV (n = 7, 5.7%), mature cataract (MC) [n =14, 11.4%] and hypermature cataract (HMC) [n = 2, 1.6%]. Most cases of high density lenticular opacities (NS IV, MC, and HMC) were carried out in the third month.

Table 1. *Table showing various parameters analyzed*

Parameters						
Age	**Mean**	**SD**	**Mode (years)**		**Range (years)**	
	63.19±6.6	6.57	60		40-80	
Sex	Male		Female			
	n	%	n		%	
	49	39.8	74		60.2	
Laterality (Eye)	Right		Left			
	n	%	n		%	
	63	51.2	60		48.8	
Grade of cataract	**1st Month**		**2nd Month**		**3rd Month**	
	n = 18	%	N = 41	%	n = 64	%
NS2£	11	61.1	27	65.9	39	60.9
NS3£	6	33.3	7	17.1	10	15.6
NS4	-	-	1	2.4	6	9.4
MC	1	5.6	6	14.6	7	10.9
HMC	-	-	-	-	2	3.1
Intra-op Complications	**1st Month**		**2nd Month**		**3rd Month**	
	n = 18	%	n = 41	%	n = 64	%
Scleral button holing	2	11.1	-	-	-	-
PE*	2	11.1	5	12.2	6	9.4

PCR[#]	3	16.7	5	12.2	8	12.5
Aphakia	3	16.7	1	2.4	2	3.1
IOL drop	1	5.6	-	-	-	-
None	7	38.9	30	73.2	48	75.0

Keys:
SD= Standard deviation
[£]= with or without posterior subcapsular/cortical opacities
*=with or without iridodialysis/Descemet's stripping
[#]= Posterior capsular rent and/or zonular dialysis (with or without vitreous disturbances)

According to the WHO guidelines and recommendations (table 2), the worst uncorrected visual acuity (UCVA) was recorded in the first 18 patients operated in the first training month. However, 4-weeks post-operative best-corrected (BCVA) was better in patients operated in the second and third training month (Table 3).

Table 2. *World Health Organization guidelines and recommendations for the post-operative outcome of cataract surgery with IOL*

		Uncorrected post-op VA	Corrected post-op VA
Good	6/6-6/18	80%+	90%+
Borderline	<6/18-6/60	15%	<5%
Poor	<6/60	<5%	<5%

Table 3. *Post-operative corrected and uncorrected visual acuity*

POD-1 day UCVA	**1st Month**		**2nd Month**		**3rd Month**	
	n = 18	%	N = 41	%	n = 64	%
6/6-6/18	2	11.1	6	14.6	11	17.2
<6/18-6/60	10	55.6	25	61.0	36	56.3
<6/60	6	33.3	10	24.4	17	26.6
POD-4 weeks UCVA	n = 17		n = 37		n = 60	
6/6-6/18	8	47.1	24	64.9	40	66.7
<6/18-6/60	6	35.3	12	32.4	19	31.7
<6/60	3	17.6	1	2.7	1	1.7
Absent	1	-	4	-	4	-
POD-4 weeks BCVA	n = 17		n= 37		n = 60	
6/6-6/18	13	76.5	35	94.6	55	91.7
<6/18-6/60	3	17.6	1	2.7	5	8.3
<6/60	1	5.9	1	2.7	0	0
Absent	1	-	4	-	4	-

Key:
UCVA= Uncorrected visual acuity
POD = Post-operative day

Complication rates from the first to the last month were 44.4%, 24.4% and 21.9% respectively. The overall complication rate was 30.9%, posterior capsular rent (PCR) being the most frequent complication accounting for nearly half (16 of 38 eyes, 42%) of all complications. Due to insufficient capsular support, 6(4.9%) eyes were left aphakic and planned for secondary IOL implantation.

IOL drop (6.5%) and scleral button holing (11.1%), both occurring only in the first training month, were the least intraoperative complications.

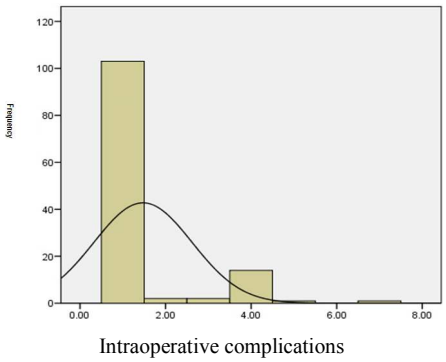

Figure 1. *Pattern of Intraoperative complications*

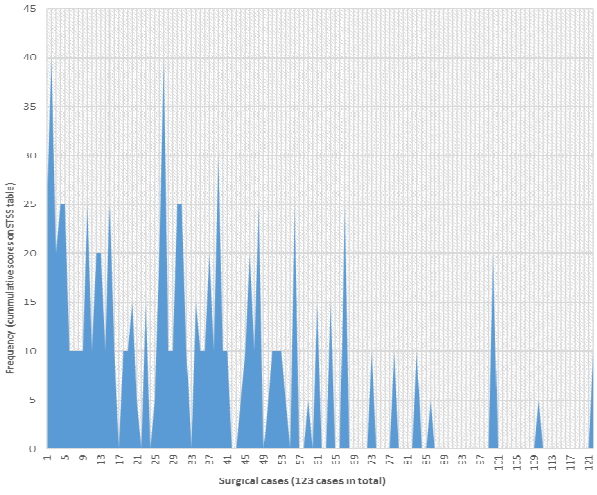

Figure 2. *Pattern of supervisors's assistance during each surgical case (a total of 123 surgeries)*

Figure1 shows that complication rates declined as training progressed. Figure 2, obtained from STSS scores, details degree of supervisors' intervention in surgeries which was highest in the first month of training and declined as training progressed. Also in figure 2, each spike

represents extent of supervision. The height (as per the frequency axis) of the spikes determine the extent of trainers' involvement in supervision per surgical case. The horizontal axis, denoted 'surgical cases', stands for operated cases. The first 65 cases recorded the highest supervision demonstrated with tallest and most frequent spikes as against the last 58 patients characterized by sparse and stunted spikes.

Fischer's Exact test for intraoperative complications and extents of supervision showed X2 = 63.88, P = 0.012 (95% confidence interval, CI = 0.01-0.014) and two-sided ANOVA, X2= 50.522, df = 35, p=0.043. This was statistically significant. Multiple logistic regression of the association of intraoperative complications with dependent variables showed, age (df = 1, F = 1.487, P = 0.225), sex (df = 1, F = 0.219, P = 0.641), laterality (df = 0.035, F = 0.139, P = 0.710) and grade of nucleus (df=1, F=5.608, P = 0.02). Only grade of nucleus was statistically significant.

4. Discussion

Senile cataract being the commonest form of cataract, the average age of the subjects in this study was 63.2+6.6 years. This is similar to studies by Isawumi et al[18] and Adewoye et al.[19] Although participants were significantly skewed towards females, gender showed no statistically significant association with intraoperative complications or postoperative UCVA. In a large retrospective series of 79,777 patients by Aravind et al[4], sex (P = 0.42) and age (P = 0.21) were not significantly associated with intraoperative complications. Cataract uptake is more likely in females because they have tendencies to be more receptive to the often unfamiliar camp officials who go weekly to harvest cataract cases. Additionally, surgeries being offered free, the issue of costs or waiting for the husbands to pay for surgeries did not arise.

As with all surgeries, MSICS also needs experience to be mastered, especially construction of leak-proof valvular tunnel, competent capsulorrhexis, nucleus prolapse and delivery. Phacoemulsification, other than cost, has prolonged and sometimes traumatic learning curve. Phacoemulsification had higher complication rates (4.8%) compared with MSICS (1.46%) among trainees in an Indian study.[4] Despite much lower rate of PCR in the current study, the overall complication rate was higher than that reported by Aravind et al[4]. Aravind et al.[4] enrolled more patients (79,777 against current study's 123), involved multiple trainees at various pre-MSICS training experience, included ECCE cases in data computation and had different study's definition of complications. These could be responsible for the different prevalent figures.

In the current study, the measured parameters (post-op UCVA, complications, and supervision levels) were worst in the first month (first 18 patients). By the second month (next 41 patients), there was a remarkable improvement in these parameters. The third month (last 64 patients) showed only marginal improvement with regards to post-op UCVA, BCVA and intraoperative complication, although the need for supervisors to intervene diminished significantly. The grade of lenticular opacity was found to be statistically significant as per complications. Higher nuclear densities are associated with bigger nuclei that often pose challenges during prolapse and delivery from the anterior chamber. This could be associated with iris prolapse or even iridodialysis. Hypermature cataracts have thin fragile capsules that are susceptible to rents especially when a large nucleus is forced through a residual anterior capsular tear or poorly constructed capsulorrhexis margins.

It can be said that after the first 64 patients, the need for strict supervision diminished. It was also noted that trainee experienced most complications on operating the initial 18 consecutive patients. Thereafter, post-operative UCVA became averagely better and intraoperative complications declined. On the contrary, the learning curve for trainee phaco surgeons has been determined to be 80 cases as against 18 cases of this study.[20] Ashok[2] reported that learning phacoemulsification requires more patients if the trainee is not conversant with MSICS. Similar to the current study, in Nepal, it was observed that it required about 20-30 assisted MSICS surgeries to master nucleus hook extraction through the tunnel once trainees were conversant with ab-externo extracapsular surgery.[16] Transition to phacoemulsification is easier if one has mastered MSICS, as familiarity of steps (scleral tunnel incision, capsulorrhexis, hydroprocedures, et cetra.) common to both helps reduce the incidence of complications while learning phacoemulsification.[2]

4.1. Limitations of the Study

The results and recommendations of this study must be understood within the context of its limitations. Self-appraisal of surgical training experience and its outcome relied on obtaining detailed information from an individual to potentially complex situations. As such, these results are complementary to more quantitative data exploring the issue. Given the subjective nature, these results can only be applied with caution to trainee MSICS surgeons. The involvement of many trainees in a multi-center setting will in some ways obviate subjectivity.

Being a retrospective study, various parameters were not standardized: VA was taken by different nurses with supposedly different skills and tolerance. For example, a patient could peep through a better unoperated eye without the nurses knowing. The quality and extent of vision depend, at least in part, on the health of ocular refractive media, fovea and retinal nerve fiber-geniculate-cortical pathway. Surgical training progress based on Snellen's visual outcome, therefore, is fraught with inherent underestimation. Standardized objectively graded intraoperative complication scales and adaptation of STSS appear to reduce the shortcomings that may have arisen from use of postoperative UCVA.

4.2. Recommendations

Today many surgeons are keen to convert from sutured to sutureless cataract surgery. Good patient selection is key to training MSICS surgeons. The ideal case should be immature cortical or LOC grade II-III nuclear sclerosis that can be molded through the scleral tunnel. There should be intact zonular integrity, adequate intraoperative mydriasis and healthy cornea (in terms of clarity, thickness and number of endothelial cells). The trainee should be encouraged to perform a more familiar can-opener capsulotomy while concentrating on the tunnel construction and geometry at initial stages. The need to remove redundant capsular tags following can-opener capsulotomy or queer rhexis margin with vannas to avoid extension of a capsular marginal tear to posterior capsule during nucleus prolapse and rotation cannot be overemphasized. Some degree of competence in conventional ECCE appears to ease conversion to sutureless tunneled MSICS. The practice that allows for modest mastery of ECCE as currently ensured in our training center have been associated with reduced duration of training, reduced adverse intraoperative complications and improved overall quality of surgical outcome.

5. Conclusion

In this study, the steepest learning curve was in the first month of training. Although extent of supervisors' intervention was significantly reduced in the third month, UCVA, BCVA and complications, were not significantly different from the second month.

Appendix 1.

Intraoperative Complications by OCTET Grade and Score

SN	Intraoperative complications	Grade	Score
1	Button hole in the flap	1	0
2	Scleral tunnel- premature entry	1	0
3	Descements stripping	1	0
4	Positive pressure wound	1	0
5	Rhexis tear	3	6
6	Difficult nucleus delivery	1	0
7	Zonular dialysis-vitreous disturbance (No)	2	6
8	Zonular dialysis- vitreous disturbance (Yes)	3	10
9	Iridodialysis	2	4
10	PC rent- vitreous disturbance (No)	2	6
11	PC rent- vitreous disturbance (Yes)	3	10
12	Vitreous disturbance	3	6
13	Failure to implant lens	3	10
14	Nucleus drop into	3	10
15	IOL drop	3	10
16	Expulsive choroidal haemorrhage	3	13

Appendix 2.

SICS Trainee's Supervision Scores (STSS)-Proposed by this Study

SN	Steps performed by supervisor	Grade	Scores
1	None	1	0
2	Assisted in conjunctival peritomy	2	5
3	Assisted in haemostasis control (cauterization)	2	5
4	Assisted in reposition of conjunctiva after surgery	2	5
5	Assisted in tunnel construction	4	15
6	Assisted in A/C entry/tunnel expansion	3	10
7	Assisted in rhexis	4	15
8	Assisted in hydrodissection/delineation	3	10
9	Assisted in nucleus prolapse	3	10
10	Assisted in nucleus delivery	3	10
11	Assisted in cortical wash (sub-incisional)	2	5
12	Assisted in cortical wash (other than sub-cortical wash)	3	10
13	Assisted in IOL placement (entire implantation)	4	15
14	Assisted in dialing IOL after trainee's implantation	2	5
15	Assisted in Visco wash after IOL implantation	2	5
16	Patient uncooperative, prolonged surgery, supervisor takes over	3	10

References

[1] Gogate P, Deshpande M, Nirmalan PK. Why do phacoemulsification? Manual small-incision cataract surgery is almost as effective, but less expensive. Ophthalmology. 2007; 114(5): 965-968.

[2] Ashok G. Clinical Significance and Relevance of Small Incision Cataract Surgery in the 21st Century Era. In: Ashok G, Amulya S, Franscisco J, Carlos I. Keiki RM, Dhull CS, editors. Master's Guide to Manual Small Incision cataract surgery (MSICS). Japee, India 2009. p. 3-9.

[3] Khanna R, Pujari S, Sangwan V. Cataract surgery in developing countries. *Curr Opin Ophthalmol* 2011; 22:10–14

[4] Aravind H, David F, Mascarenhas R, Madhu S. Complication rates of phacoemulsification and manual small-incision cataract surgery at Aravind Eye Hospital. *J Cataract Refract Surg* 2012; 38:1360–69

[5] Muhammad HQ. Non Phaco Sutureless Cataract Surgery with Small Scleral Tunnel Incision Using Rigid PMMA IOLS. *Pak J Ophthalmol* 2007; 23(1):1-5.

[6] Thomas R, Navin S, Parikh R. Learning micro incision cataract surgery without the learning curve. Indian J Ophthalmol 2008; 56(2):135-7.

[7] Thomas R, Naveen S, Jacob A, Braganza A. The visual outcome and complications of residents learning phacoemulsification. *Indian J Ophthalmol*. 1997; 45:215-19.

[8] Spaeth GL. Phacoemulsifcation: A senior surgeon's learning curve. *Ophthalmic Surg*. 1994;25: 504-9.

[9] Muralikrishnan R, Venkatesh R, Prajna NV, Frick KD. Economic cost of cataract surgery procedures in an established eye care centre in Southern India. Ophthalmic *Epidemiol* 2004; 11:369–80

[10] Albrecht H. Sutureless Non-phaco Cataract Surgery: A Solution to Reduce Worldwide Cataract Blindness? *Comm Eye Health* 2003; 16: 51-52

[11] Blumenthal M, Ashkenazi I, Assia E, Cahane M. Small incision, manual extracapsular cataract extraction using selective hydrodissection. *Ophthalmic Surg* 1992;23:699-701.

[12] Kansas P. Phacofracture. In: Rozakis GW, Anis AY, et al., editors. Cataract Surgery: Alternative Small Incision Techniques. Thorofare (N.J): Slack Inc; 1990. pp. p. 45-70

[13] Ruchi G, Malik KPS. Nuclear Management. In: Ruchi G, Malik KPS editors. Manual of Small Incision Cataract Surgery. 2nd edn. Publisher, India 2012. Pg. 34-47.

[14] Fry LL. The phaco sandwich technique. In: Rozakis GW (ed.), Cataract Surgery: Alternative Small incision techniques. *Thorofare NJ Slack* 1990; 91-110.

[15] Srinivasan A. Nucleus Management with irrigating Vectis. Indian J Ophthalmol 2003; 15: 5-12

[16] Hennig A. Nucleus management with Fishhook. *Indian J Ophthalmol* 2009; 57: 35-7.

[17] Guzek JP, Ching A. Small-incision manual extracapsular cataract surgery in Ghana, West Africa. *J Cataract Refract Surg*. 2003; 29(1): 57-64.

[18] Isawumi MA, Soetan EO, Adeoye AO, Adeoti CO. Evaluation of Cataract Surgery Outcome in Western Nigeria. *Ghana Med J.* 2009; 43(4):169–74.

[19] Olawoye OO, Ashaye AO, Bekibele CO, Ajayi BGK. Visual Outcome after Small Incision Cataract Surgery in Southwestern Nigeria. *Nig J Ophthalmol* 2011;18(2):40-44.

[20] Randleman JB, Wolfe JD, Woodward M, Lynn MJ, Cherwek DH, el al. The resident surgeon phacoemulsification learning curve. *Arch Ophthalmol*. 2007; 125(9):1215-19.