

## Impact of a structured training program to enhance skills in phacoemulsification surgery

Anuprita Gandhi Bhatt, Kuldeep S Dole, Madan Deshpande, Khurshed Bharucha, Kalyani VKS

**Purpose:** The aim of this study was to determine whether the introduction of a structured short-term phacoemulsification training program improved the ICO-OSCAR (International Council of Ophthalmology's Ophthalmology Surgical Competency Assessment Rubric) score and the learning curve of the trainees and decreased the complication rates of the cases. **Methods:** This study was a retrospective, observational study conducted in a tertiary eye care hospital in India. The study was conducted from March 2018 to October 2019 based on a structured phacoemulsification training program introduced in January 2019. The trainees enrolled in the phacoemulsification training program were divided into two groups: Group 1 ( $n = 33$ ), who underwent training before the introduction of the structured program, and Group 2 ( $n = 29$ ), who underwent the training after the introduction of the structured training program. Each trainee performed 20 cases. Group 1 training consisted of wet-lab and phacoemulsification surgeries. Group 2 training program comprised three modules over 5 weeks and a preassessment examination. Premodule 1 imparted cognitive skills; Module 1 was on structured wet-lab, Module 2 was about phacoemulsification step surgery, and Module 3 had independent complete surgeries. Group 2 also underwent compulsory Observation of cases being performed in the operation theater, surgical video recording review, and formative feedback. Mean OSCAR score comparison was done for both the groups. The OSCAR score was also calculated case-wise to obtain the learning curve with respect to the entry and exit levels, by classifying the trainees in each group as Novice, Beginner, Advanced Beginner, or Competent. A comparison of the posterior capsular rupture (PCR) rates and vision at discharge of all the cases was done. **Results:** Group 2 had a significantly better mean OSCAR score than Group 1 (4.03 and 3.43, respectively;  $P < 0.001$ ). The PCR rate of the cases was significantly lower in Group 2 than in Group 1 (9.14% and 20.30%, respectively;  $P < 0.001$ ). Group 2 had a significantly better visual acuity outcome of the cases than Group 1. Group 1 started as Novice (OSCAR score: 2), whereas Group 2 started as Beginner (OSCAR score: 3). Group 2 reached the Advanced Beginner level eight to 10 cases prior to Group 1. **Conclusion:** A structured training curriculum can make a significant difference in the training experience of the trainees and enable better surgical outcomes and a decrease in the complication rates.

**Key words:** Modules for training, phacoemulsification training, posterior capsular rupture, short term, structured training

Cataract surgery is one of the most frequently performed surgical procedures worldwide.<sup>[1]</sup> Phacoemulsification is the preferred technique for performing a cataract surgery as it gives better uncorrected visual acuity in a larger proportion of patients at 6 weeks as compared with the manual small-incision cataract surgery<sup>[2]</sup> and has lower surgically induced astigmatism.<sup>[3]</sup> The residency training program in the majority of the medical schools across India offers minimal or no exposure to phacoemulsification surgery techniques.<sup>[4]</sup> In a survey to estimate the prevalence and causes of blindness, using the rapid assessment of avoidable blindness methodology in Pune, India, it was concluded that the cataract surgical complications contribute to 6.5% of the total avoidable blindness.<sup>[5]</sup> Many ophthalmologists take up long-term or short-term training programs to improve their

surgical skills after their postgraduate training. In addition, ophthalmologists already in practice are also keen on acquiring phacoemulsification surgical skills. To bridge this gap, various short- and long-term training programs have been established by different institutions around India.

A 5-week short-term phacoemulsification training program was being conducted in our institute for the past 10 years, where the trainees had wet-lab training and hands-on training for surgical cases [Table 1]. We underwent a modification in the past year in the existing training curriculum and established a more structured training program.

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Department of General Ophthalmology, H. V. Desai Eye Hospital, Pune, Maharashtra, India

**Correspondence to:** Dr. Anuprita Gandhi Bhatt, 104, Twin Towers A, Behind Wireless Colony Aundh, Pune – 411 007, Maharashtra, India. E-mail: anuprita.gandhi@gmail.com

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**Table 1: Salient features of the two programs**

Salient features of the programs	Prestructured training program (Group 1)	Poststructured training program (Group 2)
Enhancement of cognitive abilities by online module	No	Yes
Pretraining assessment	No	Yes
Didactic lectures	Yes	Yes
Wet-lab training	Supervised training	Structured, supervised, and formative feedback-assisted training with grading of the wet-lab cases by OSSCAR score
OT observation	Yes, voluntary as per trainee's need	Yes, compulsory
Surgical video recording review and feedback	No	Yes
Stepwise introduction of phacoemulsification surgery	Yes	Formative feedback-assisted introduction of steps of phacoemulsification surgery
Independent phacoemulsification surgery on patients	Yes	Stepwise supervised surgery on patients with timely feedback
Online resources	No	Yes
Detailed time-wise guideline and monitoring of the program	No	Yes

OSSCAR=Ophthalmology Simulated Surgical Competency Assessment Rubric

The International Council of Ophthalmology (ICO) has developed a competency-based assessment rubric to assess the trainee's performance during the phacoemulsification surgery called the ICO-OSCAR (International Council of Ophthalmology's Ophthalmology Surgical Competency Assessment Rubric) score.<sup>[6]</sup> This rubric can be utilized effectively to assess the trainee's performance and in turn the impact of a surgical training program.<sup>[7]</sup> This rubric can be used not only in assessing the program but also in understanding the learning curve of the trainee during the training program. In a pilot study done elsewhere, the ICO-OSCAR score was used as an indicator to assess the impact on a limited number of participants, and the authors of that study recommended that a similar study needs to be conducted with larger sample size.<sup>[8]</sup>

To ascertain the impact of a structured training curriculum on surgical skills, we conducted a study to evaluate the effect on the mean ICO-OSCAR score, complication rates (posterior capsular rupture [PCR] rate), and the learning curve between the two groups of surgeons – one who underwent training before the changes were made and the other after the changes were implemented.

## Methods

After obtaining the Institutional Ethical Committee clearance, a retrospective observational study was conducted from March 2018 to October 2019 on the trainees who had undergone a short-term phacoemulsification training course at a tertiary eye care institute in India. In January 2019, there was a change in the short-term phacoemulsification training curriculum with the introduction of a more structured program. The trainees in this period were divided into two groups: Group 1 – before the introduction, and Group 2 – after the introduction of a structured training program. The PCR rate, mean ICO-OSCAR score, and the learning curve in phacoemulsification surgeries performed by the trainees in both the groups were assessed. The phacoemulsification training period was for 5 weeks, where each trainee performed 20 hands-on cases in total. The details of and differences in both the programs are shown in

Table 1. The new structured training program had modules that introduced online cognitive enhancement with assessment, formative feedback-assisted wet-lab training and hands-on surgeries, surgical video review, and compulsory observation of surgical cases being performed. The Group 1 trainees did not have these modules. The premodule was off-site, and Modules 1 to 3 were on-site. Premodule 1 started 1 week prior to the on-site training, which included enhancing cognitive abilities by completing online modules on the basics of cataract, phacoemulsification techniques, phacoemulsification instrumentation, and online pretraining assessment. Module 1 was completed in Week 1 of on-site training, which had wet-lab training and group discussions. Wet-lab training included 5 days of intensive wet-lab course with the grading of the cases with OSSCAR score (Ophthalmology Simulated Surgical Competency Assessment Rubric) score<sup>[9]</sup> and formative feedback-assisted training wherein repeat wet-lab cases were done if the trainee did not achieve the designated score. The trainee also underwent online theoretical sessions along with group discussion on incisions and wound construction, capsulorrhexis, phacodynamics, and complications of surgery. Observing phacoemulsification cases being performed by an expert and getting hands-on training in A-scan biometry were compulsory. Module 2 was completed in the second and the third week, which consisted of supervised phacoemulsification step surgery with ICO-OSCAR scoring of each case, occupational therapy observation, and surgical video recording review, and the online text included sessions on different types of foldable intraocular lenses and complication management in different scenarios. Module 3 was completed in Week 4, which consisted of independent phacoemulsification surgeries conducted under supervision with ICO-OSCAR scoring of each case, surgical video review, online cognitive learning objectives such as postoperative management in different scenarios, feedback, and exit exam.

The sample size was calculated to compare the PCR rates of phacoemulsification surgeries performed by the trainees in the two types of training programs during the study period. We assumed the PCR rates to be 6.40% in Group 1 and 2.64%

in Group 2, respectively. The sample size was calculated for 95% confidence interval, 80% power, and taking the ratio of the exposed to unexposed to be 1. So the sample size obtained was 509 cases in each group. The training program enrolled those ophthalmologists who had cleared postgraduation in ophthalmology and had an experience of performing minimum of 50 small-incision cataract surgeries. To assess the influence of age on the outcome variables, we divided the trainees into three groups, namely,  $\leq 30$  years (very young), 31–40 years (young),  $> 40$  years (middle aged). They were also divided based on the past surgical experience of phacoemulsification surgery into three groups, namely, no phacoemulsification surgeries performed (no phaco), assisted in phacoemulsification cases (assisted phaco), and performed up to 10 independent phacoemulsification cases (limited phaco). The ICO-OSCAR score was used to assess the trainee's performance during the training program in both the groups, and they were categorized as per the guidelines given in the scoring. This cataract surgery evaluation breaks down the surgical procedure into 20 individual steps, and each step is graded on a scale of Novice, Beginner, Advanced Beginner, and Competent. A description of the performance necessary to achieve each grade in each step is given (<http://www.icoph.org/downloads/ICO-OSCAR-Phaco.pdf>). It collectively divides the surgeon's skill into Novice (score 2), Beginner (score 3), Advanced Beginner (score 4), and Competent (score 5), which allows surgical skill improvement to be measured quantitatively. After the completion of the surgery, the obtained scores were reviewed with the trainee for immediate feedback, and a plan for improvement was developed. The trainees maintained a logbook to record their surgical performance. OSSCAR scoring was used to grade wet-lab cases in Group 2, wherein the trainee was graded as Novice, Beginner, and Advanced Beginner. The trainee was made to perform wet-lab cases till they reached the Advanced Beginner grade of the OSSCAR score.

There were 10 trainers in total. All of them were inducted with the standard surgical training protocol, outcome measures, assessment rubrics, and thresholds for "take over" of cases. All the trainers had a minimum of 5 years of experience in phacoemulsification. As different faculty members were grading the same trainees, to minimize the interobserver variability, all faculty members graded a few recorded surgical videos together to ensure that their grading was similar. A senior surgeon evaluated the case preoperative, and only the cases with the following criteria were allotted to the trainees: Age  $> 50$  years, an uncomplicated cataract case with nuclear sclerosis Grades 2 to 3 with no posterior pole pathologies, and not one-eyed. The patients with the above characteristics were randomly allotted to the trainees, and each step of the surgery was supervised by a trainer, and if any complication occurred during the live surgery on the patients, the faculty would complete the case to ensure that the surgical outcome and vision were not compromised. An unpaired *t* test was used for the comparison of the mean OSCAR scores and the complication rates of all the cases and their association with age and past surgical experience between the two groups. A Chi-square test was used to compare the number of trainees in the three age groups and in the past surgical experience groups and to compare the visual acuity of the cases at discharge. The software used was SPSS (Statistical Package for Social Sciences) Version 25.0.

## Results

A total of 660 surgeries were performed by 33 trainees in Group 1, and 580 surgeries were performed by 29 trainees in Group 2. Table 2 shows the baseline characteristics of the trainees with respect to age and past surgical experience, and the difference between both the groups for each of the above variables was not statistically significant; hence, both the groups were comparable with each other. Table 3 shows the mean OSCAR score and the complication rates of all cases in both the groups. The PCR rate was 20.30% in Group 1 and 9.14% in Group 2 with  $P < 0.001$ , which is statistically significant. The mean OSCAR score in Group 1 was 3.43, whereas in Group 2 it was 4.03 with  $P < 0.001$ , which is statistically significant. Unpaired *t* test was used to compare the results. Table 3 also shows the visual acuity at discharge. A total of 429 cases (65%) in Group 1 and 487 cases (84%) in Group 2 had vision  $\geq 6/18$ . Thirty (4.5%) cases in Group 1 and 14 cases (2.41%) in Group 2 had vision  $< 6/60$ . After performing the Chi-square test, the *P* value was 0.013, which is significant. Table 4 shows the association of age and past surgical experience with the mean OSCAR score and complication rates of all cases. It is observed that in all the age groups and past surgical experience groups, Group 2 had a better OSCAR score and lower complication rates than Group 1 with  $P < 0.001$ , which is significant. In both the groups, it was seen that the younger age group and more previous surgical experience had better OSCAR scores and lower complication rates with  $P < 0.001$ , which is statistically significant. Graph 1 shows the learning curve plotted against the OSCAR score case-wise from Case 1 to Case 20. While Group 1 started off the training as Novice and exited as Advanced Beginners, Group 2 trainees started off as Beginners and exited as Near-Competent trainees. The trainees in Group 2 attained the Advanced Beginner stage 10 cases prior to that of Group 1.

## Discussion

It was observed that the trainees in the structured training group (Group 2) had better OSCAR scores, lower complication rates, and better visual acuity at discharge than the trainees in the prestructured group (Group 1). The learning curve showed that Group 2 achieved competency 10 cases prior to Group 1 at exit.

**Table 2: Description of trainee factors**

	Group 1 Number	Group 2 Number	<i>P</i>
<b>Age</b>			
$\leq 30$ years	10 trainees (200 cases)	8 trainees (160 cases)	0.833
31-40 years	17 trainees (340 cases)	17 trainees (340 cases)	
$> 40$ years	6 trainees (120 cases)	4 trainees (80 cases)	
<b>Past surgical experience</b>			
No phaco	11 trainees (220 cases)	9 trainees (180 cases)	0.947
Assisted phaco	13 trainees (260 cases)	11 trainees (220 cases)	
Limited phaco	9 trainees (180 cases)	9 trainees (180 cases)	

phaco=phacoemulsification

**Table 3: Comparison between the OSCAR score, Complication Rate, and Visual Acuity at discharge between Groups 1 and 2**

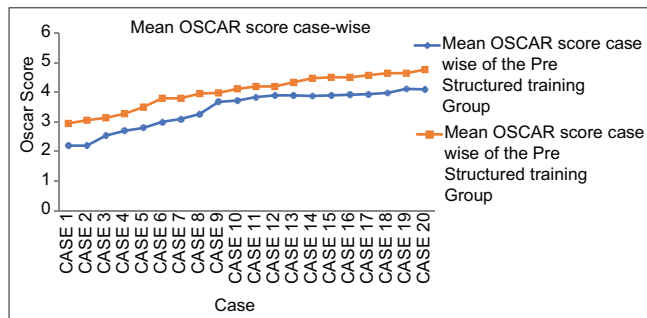
	Group 1 (33 Trainees and 660 Cases)	Group 2 (29 Trainees and 580 Cases)	P
Complication rate (%)	20.30 (134 cases)	9.14 (53 cases)	<0.001
Overall mean OSCAR score	3.43	4.03	<0.001
Visual acuity at discharge			
Percentage of cases in Good visual acuity group ( $\geq 6/18$ )	65% (429 cases)	84% (487 cases)	0.013
Percentage of cases in poor visual acuity group ( $<6/60$ )	4.5% (30 cases)	2.5% (14 cases)	

OSCAR=Ophthalmology Surgical Competency Assessment Rubric

**Table 4: Association of trainee variables with mean OSCAR score and complication rate of all cases**

	Overall mean OSCAR score			Complication rate of all cases		
	Group 1	Group 2	P	Group 1	Group 2	P
Age						
$\leq 30$ years	3.62	4.05	0.034	18.50% (37 cases)	6.88% (11 cases)	<0.001
31-40 years	3.38	4.03	<0.001	20.59% (70 cases)	9.41% (32 cases)	<0.001
$>40$ years	3.28	3.98	<0.001	22.50% (27 cases)	12.50% (10 cases)	0.044
Past surgical experience						
No phaco	3.07	3.98	<0.001	24.09% (53 cases)	12.78% (23 cases)	<0.001
Assisted phaco	3.50	4.02	<0.001	19.62% (51 cases)	8.64% (19 cases)	<0.001
Limited phaco	3.79	4.07	<0.001	16.67% (30 cases)	6.11% (11 cases)	<0.001

OSCAR=Ophthalmology Surgical Competency Assessment Rubric, phaco=phacoemulsification



**Graph 1: Learning curve**

In our study, the mean OSCAR score before implementation of the structured training program was 3.43 and after implementation of the structured training program was 4.03. The poststructured training program OSCAR score of 4.03 is comparable with 4.3 obtained in the third month of training in the study done by Yu *et al.*<sup>[8]</sup> The OSCAR score of the poststructured training program is comparable, although there is a minor difference that can be attributed to the period of training, which is 5 weeks in our program and 3 months in Yu *et al.*'s study.<sup>[8]</sup> The authors concluded that the trainees succeeded in performing phacoemulsification safely and skillfully through a limited short period of training by wet-lab exposure, deliberate practice in patients, and frequent formative feedback provided by the OSCAR tool.<sup>[8]</sup> Our study supports and expands the findings of Yu *et al.*, wherein we conclude that the modules had a significant impact on improving the OSCAR score and hence the overall outcome of the phacoemulsification surgery. In the multivariate analysis, we concluded that age has a limited effect on the outcome of surgeries, but the past surgical experience had a positive impact

on the final surgical outcome. In assessing the learning curve, we observed that whereas the trainees in Group 1 exited as Advanced Beginner (mean OSCAR score 4.1), the trainees in Group 2 exited as Near-Competent surgeons (mean OSCAR score 4.77); hence, the trainees in Group 2 are competent enough to perform independent phacoemulsification cataract surgeries. We also observed that the trainees in Group 2 attained the Advanced Beginner stage 10 cases prior to that of Group 1, reinforcing the importance of Modules 1 and 2.

A recent literature review of the complication rates of resident-performed cataract surgeries reported that the rate of vitreous loss ranged from 1.8% to 19% and that the rate of posterior capsule tear ranged from 0.6% to 18%.<sup>[10,11]</sup> Borboli-Gerogiannis *et al.*<sup>[12]</sup> concluded that the implementation of a comprehensive cataract surgery curriculum focusing on patient outcomes resulted in a decrease in the rate of intraoperative complications. Our study supports these findings, where we found a significant decrease in the PCR rates in Group 2 than in Group 1.

In both the groups, it was seen that the posterior capsular tear rate is higher in older surgeons undergoing training. Whereas older surgeons would be thought to have more surgical experience, it can perhaps be inferred that this experience did not include exposure to phacoemulsification surgery. In the analysis with respect to past surgical experience in both the groups, it is seen that more the past surgical experience better the ICO-OSCAR score and lower the PCR rate. In the "no phaco" group, where the trainees had only performed small-incision cataract surgeries, the complication rate in Group 2 was 12.78% (23 cases of the 180 cases), which is above that recommended by the World Health Organization, which states that the complication rate should be less than 10%.<sup>[12]</sup> Hence, it is concluded that the short-term training

programs are not suitable for entirely inexperienced trainees in phacoemulsification surgery. These trainees need to be enrolled in a separate program where the training program and methodology are different, with more wet-lab exposure and training for a longer period. Cognitive enhancing in a trainee is important in understanding the situation while performing the surgery, decision-making, and action versus outcome awareness of the decision taken. It is important to teach and assess decision-making along with the technical aspects of the surgery as improper decision-making is the cause of many complications in the surgery.<sup>[13]</sup> Our study supports this observation, wherein we observed that a thorough prior knowledge about the phacoemulsification machine, phacodynamics, anatomical layout, various surgical techniques, and complication management eases the learning curve and supports the decision-making. Wet-lab practices help in understanding the complex anatomy as well as attaining hand-eye coordination and practicing basic microsurgical techniques. Multiple studies have reported that simulator and wet-lab training improves the surgical performance in ophthalmology, shortens the learning curve of the residents, shortens the surgical time, and decreases the surgical morbidity and the risk of iatrogenic trauma.<sup>[14-18]</sup> We observed that the wet-lab sessions helped in getting foot pedal control, basic control over the phacoemulsification machine, and understanding the fluidics apart from the above-mentioned objectives. Also, it was observed that using assessment rubrics and repetition of wet-lab sessions to achieve the desired competency level improves efficiency and safety and decreases the complication rate. Video recording review with feedback from the trainer has proven to be beneficial in understanding the shortcomings and surgical training. It also allows the trainee to assess their own surgical performance and rectify in the following surgeries. Trainees are expected to perform rigorous self-evaluation of their surgical skills as an index of professional competence.<sup>[1]</sup> It benefits a trainee to smoothly transition from phacoemulsification step surgery to complete independent surgeries with supervisory discussions. Observational learning is an effective method for learning surgical skills. Research has shown that observational learning activates the same cortical motor regions as physical practice<sup>[19,20]</sup> and allows complex skills to be learned more quickly. We also promote observational learning, and we assume that the significant improvement in the overall OSCAR score in Group 2 as compared with Group 1 and a decrease in the complication rate in Group 2 are as a result of all the modules combined together. Strategically introducing phacoemulsification stepwise also helps in confidence gaining and improving the surgical outcomes.

The interpretation of the present study is as follows: A structured training curriculum with the enhancement of the cognitive abilities, wet-lab training with formative feedback, phase-wise introduction of surgery, observing surgeries being performed, and video recording review with feedback-assisted cases can make a significant difference in the training experience of a trainee in achieving better surgical outcomes and a decrease in complication rates. More past surgical experience is associated with better surgical outcomes. This article tries to introduce a layout of the structured training program for short-term phacoemulsification training programs to obtain the maximum benefit in a shorter span of time along

with the guidelines for trainee selection for these short-term phacoemulsification training programs.

The limitation of this study was that as there was an emphasis on monitoring outcomes and a low threshold of "take over" of cases, which might have contributed to the lower complication rates that we observed in the structured training group. The other limitation is the lack of follow-up. A follow-up on these trainees in the poststructured training group is required to know the performance in their individual setups or organizations with respect to their outcomes.

## Conclusion

In the short-term phacoemulsification program a structured training curriculum can have a significant impact in the surgical outcome with considerable decrease in the complication rate and flattening of the learning curve. This positive impact is attributed to formative feedback assisted wet-lab training, cognitive enhancement, OT observation, stepwise introduction of the surgical steps and video-recording reviews.

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## Conflicts of interest

There are no conflicts of interest.

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