

Intraoperative complication rates in cataract surgery performed by resident trainees and staff surgeons in a tertiary eyecare center in Hungary

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Abstract

• **AIM:** To compare the incidence of intraoperative complications during primary phacoemulsification (phaco) surgery between resident surgeons (residents) and staff surgeons (specialists) and to objectively determine the difficulty of stages in phaco surgery.

• **METHODS:** This retrospective study included cases of phaco cataract surgery performed between January and December 2019. There were no exclusion criteria. For each patient, demographics, clinical history, case complexity, type of surgeon, and operative details were reviewed. Primary outcomes included intraoperative complication rates and the objective measure of difficulty in the steps of the surgery performed by residents and specialists.

• **RESULTS:** A total of 3272 cases were included; 7.4% ($n=241$) of cases were performed by residents. The overall complication rate was 5.4% ($n=177$). The intraoperative complication rate was significantly higher ($P<0.001$) in residents ($n=33$, 13.7%) than in specialists ($n=144$, 4.8%). The most frequent complications were posterior capsule tear ($n=85$, 2.6%), anterior capsule tear ($n=50$, 1.53%), zonular fiber loss ($n=45$, 1.38%), and dropped nucleus ($n=15$, 0.46%). Objectively, the most difficult steps during surgery were phaco in 66 (60.0%), capsulorhexis in 21 (19.1%), irrigation/aspiration in 13 (11.8%), hydrodissection in 9 (8.2%), and intraocular lens (IOL) implantation in 1 (0.9%) case.

• **CONCLUSION:** Intraoperative complication rates are higher in residents than in specialists. The order of objective difficulty in phaco surgery steps is in line with the subjective findings of other surveys, revealing that the most challenging parts of phaco surgery are phaco and capsulorhexis.

• **KEYWORDS:** cataract; intraoperative complications; resident; phacoemulsification; staff surgeon

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INTRODUCTION

Cataract surgery is one of the most commonly performed ophthalmic surgeries worldwide. Thus, learning to perform cataract surgery with phacoemulsification (phaco surgery) is an essential part of ophthalmology training programs^[1]. Because of the increasing availability of surgical devices and technical advancement, complication rates are decreasing. However, intraoperative complication rates may differ between staff surgeons (specialists) and resident trainees (residents)^[2-3]. Only a few large-scale studies have compared intraoperative complication rates between specialists and residents^[4-6], and differences between these studies may be due to different structures in residency trainings. Thus, it is important to gain insight from different countries with different education systems to develop more effective training methods. Although residency programs should provide trainees with the opportunity to improve their surgical skills, patient safety is always the most important aspect of the procedure. This duality poses a great dilemma in residency training programs. Phaco surgery is a single-surgeon operation, during which the specialist can supervise, leading the resident through the surgery verbally, and in case of intraoperative difficulty or complication, possibly take over and finish the surgery to ensure patient safety^[5,7-8]. Phaco surgery is a highly complex procedure with well-differentiated unique steps. Several studies have attempted to determine the difficult stages of phaco surgery for residents, albeit subjectively^[9-10]. However, to our knowledge, no study has objectively analyzed this issue. The primary aim of this study was to determine the incidence and types of intraoperative complications in phaco surgery in a tertiary eyecare center in Hungary and to compare these

complications between residents and specialists. The secondary aim was to objectively assess the order of difficulty of phaco surgery steps for residents.

SUBJECTS AND METHODS

Ethical Approval The study was conducted at a tertiary eyecare center in Hungary. The study was approved by the Regional and Institutional Committee of Science and Research Ethics of Semmelweis University, Hungary (No.121/2021). The study was performed in accordance with the Declaration of Helsinki Guidelines for Human Research. Written informed consent was obtained from the patients.

This retrospective review included 3272 consecutive patients who underwent primary phaco surgery performed by residents and specialists over a period of 1y, from January 1, 2019, to December 31, 2019, at the Department of Ophthalmology, Semmelweis University, Budapest, Hungary. For each subject, the clinical data were reviewed, which included patient demographics (sex, age, and eye laterality), clinical history (earlier intraocular surgeries), preoperative and postoperative ophthalmological status (case complexity), and operative details (usage of trypan blue dye staining, iris hooks, and intraoperative complications).

The factors contributing to the replacement of residents by specialists during phaco surgery were noted to objectively analyze which surgical steps were the most challenging for residents. Thirty-one specialists and 9 residents performed the phaco surgeries. One resident was in the second, 3 in the third, 3 in the fourth, and 2 in the fifth year of the residency. All surgeries included clear corneal incisions, continuous curvilinear capsulorhexis, and hydrodissection. Phaco techniques were performed in descending order as follows: phaco-crack ($n=1338$, 40.9%), stop-and-chop ($n=780$, 23.8%), phaco-chop ($n=659$, 20.1%), divide-and-conquer ($n=436$, 13.3%), and unclassifiable ($n=59$, 1.8%).

Statistical analysis was performed with statistica 8.0 (StatSoft Inc., Tulsa, OK, US). Data are expressed as the mean±standard deviation (SD). The Chi-square test was used to analyze the differences in the proportions of categorical variables. $P<0.05$ was considered statistically significant.

RESULTS

The study included 3272 consecutive cases. There were 1261 (38.5%) men and 2011 (61.5%) women in the study population. The mean patient age was $69.8\pm 11.1y$ (range, 17mo-98y). Of these patients, 1659 (50.7%) underwent surgery on the right eye and 1613 (49.3%) underwent surgery on the left eye. There were 3158 (96.5%) corticonuclear, 80 (2.5%) mature, 22 posterior polar (0.7%), 8 (0.2%) traumatic, and 4 hypermature (0.1%) cataract cases.

Of the surgeries, 3031 (92.6%) were completed by specialists alone and 241 (7.4%) were performed by residents or by

Table 1 Complexities during cataract surgeries

Complexity	<i>n</i> (%)
Earlier vitrectomy	156 (4.8)
High axial myopia	114 (3.5)
Corneal scar, dystrophy, or keratoconus	107 (3.3)
Narrow angles	74 (2.3)
Pseudoexfoliation or zonular fiber compromise	53 (1.6)
Small-pupil intraoperative floppy-iris syndrome	50 (1.5)
Special cataract (posterior polar, traumatic, or hypermature)	30 (0.9)
Inadequate cooperation during surgery	28 (0.9)
Earlier glaucoma filtration surgery	19 (0.6)
Earlier keratoplasty	17 (0.5)
Posterior synechiae	10 (0.3)
Anatomical differences in the body habitus	2 (0.06)
Other complexities	6 (0.2)

residents and specialists.

There were 2675 (81.8%) simple and 597 (18.2%) complex cataract surgeries. The most common complexities (Table 1) were patients with earlier vitrectomy ($n=156$, 4.8%), high axial myopia ($n=114$, 3.5%), corneal scar, corneal dystrophy or keratoconus ($n=107$, 3.3%), narrow angles ($n=74$, 2.3%), pseudoexfoliation or zonular fiber compromise ($n=53$, 1.6%), and small pupil or intraoperative floppy-iris syndrome ($n=50$, 1.5%).

Altogether, 2379 (72.7%), 816 (25.0%), and 77 (2.3%) surgeries involved topical, retrobulbar, and general anesthesia, respectively. Trypan blue dye staining of the anterior capsule was performed in 120 (3.7%) cases and iris hooks were used in 92 (2.8%) cases. Specialists ($n=573$, 96.0%) performed significantly more complex cataract surgeries ($P<0.001$) than residents ($n=24$, 4.0%).

The overall intraoperative complication rate was 5.4% ($n=177$; Table 2).

The intraoperative complication rate was significantly higher ($P<0.001$) among residents ($n=33$, 13.7%) than among specialists ($n=144$, 4.8%). The complication rate in simple cases was 5.3% ($n=127$), with intraoperative complication rates being significantly more common ($P<0.001$) in residents ($n=29$, 13.4%) than in specialists ($n=98$, 4.0%; Table 3).

The complication rate in complex cases was 8.4% ($n=50$) and was not significantly different ($P=0.13$) between residents ($n=4$, 16.7%) and specialists ($n=46$, 8.0%). The most common intraoperative complications were posterior capsule tear (PCT; $n=85$, 2.6%), PCT with vitreous loss ($n=54$, 1.65%), anterior capsule tear (ACT; $n=50$, 1.53%), and zonular fiber loss ($n=45$, 1.38%) in the whole study population. Anterior vitrectomy was performed in 58 (1.8%) cases and pars plana vitrectomy in 21 (0.6%) cases.

Among 241 surgeries performed by residents, 110 were completed with the involvement of a specialist (Figure 1).

The replacement of residents by specialists during phaco surgery occurred during phaco in 66 (60.0%), capsulorhexis in 21 (19.1%), irrigation/aspiration in 13 (11.8%), hydrodissection in 9 (8.2%), and IOL implantation in 1 case (0.9%).

Anterior vitrectomy and pars plana vitrectomy were more frequently ($P<0.001$) among resident cases ($n=12$, 5.0% and $n=6$, 2.5%, respectively) than in specialist cases ($n=46$, 1.5% and $n=15$, 0.5%, respectively).

In the whole study population, IOL was implanted in the capsular bag in 3169 (96.9%) and in the ciliary sulcus in 62 (1.9%) persons. Iris-claw IOL was fixed on the iris in 9 cases (0.3%), and 32 patients (0.9%) were left aphakic after the primary surgery. Significantly more patients ($P<0.01$) were left aphakic after the primary surgery performed by residents ($n=7$, 2.9%) when compared to primary surgery by specialists ($n=25$, 0.8%).

DISCUSSION

Cataract is a leading cause of visual impairment and phaco surgery is the most frequently performed intraocular surgery worldwide^[11-12]. Almost 4.2 million phaco procedures were performed in Europe in 2015^[13].

Cataract is usually an unavoidable side effect of aging^[14]. Nearly one-third of people aged 65 years and over have visually significant cataract in Europe^[15]. Phaco surgery is a relatively safe routine procedure with a low complication rate^[13]. However, complications do occur and can cause severe visual impairment^[16-17].

We analyzed the intraoperative complication rates for phaco surgery performed by specialists and residents and objectively determined the difficulty of each stage of the surgery at a tertiary eyecare center in Hungary. To the best of our knowledge, this is the first study to objectively report the order of difficulty in phaco surgery steps for residents. This is also the first study to report on intraoperative complication rates for primary phaco surgery, comparing specialists and residents in Hungary.

The overall intraoperative complication rate was 5.4% and was higher than that reported by other studies in Sweden (0.9%), Canada (1.8%), Portugal (4.1%), and Australia (4.9%)^[4-6,18]. Intraoperative complication rates for residents in this study was much higher (13.7%) compared to that reported by Low *et al*^[5] in Canada (2.7%), Briszi *et al*^[19] in Germany (3.8%), Fong *et al*^[4] in Australia (6.1%), Oliveira-Ferreira *et al*^[6] in Portugal (6.3%), and Ellis *et al*^[20] in the USA (7.8%). Further, complication rates during phaco surgeries performed by specialists alone in Hungary (4.8%) were slightly higher compared to that reported in Australia (2.7%)^[4] and Portugal (3.3%)^[6]. Comparisons of intraoperative complication rates between residents and specialists showed different results in different countries. While Low *et al*^[5] and Fong *et al*^[4] did not find a significant difference between the two groups, our study

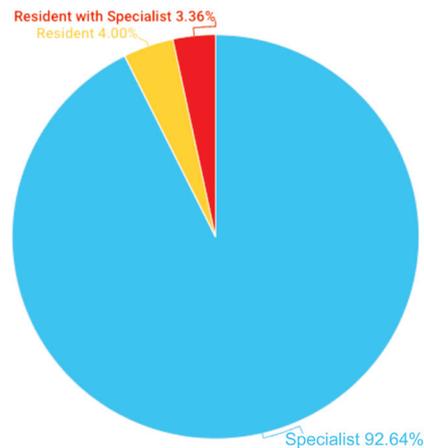


Figure 1 Resident-specialist distribution of cataract surgeries in the whole study population.

Table 2 Intraoperative complications during cataract surgery in the whole sample, in resident trainees, and in staff surgeons n (%)

Complication	Total (n=3272)	Resident trainee (n=241)	Staff surgeon (n=3031)
Posterior capsule tear	85 (2.60)	15 (6.22)	70 (2.31)
Without vitreous loss	31 (0.95)	5 (2.07)	26 (0.86)
With vitreous loss	54 (1.65)	10 (4.15)	44 (1.45)
With dropped nucleus	15 (0.46)	5 (2.07)	10 (0.33)
Anterior capsule tear	50 (1.53)	14 (5.81)	36 (1.19)
Zonular fiber loss	45 (1.38)	8 (3.32)	37 (1.22)
Intraocular lens dislocation	3 (0.09)	1 (0.41)	2 (0.07)
HypHEMA	2 (0.06)	0	2 (0.07)
Broken intraocular lens haptic	1 (0.03)	0	1 (0.03)
Expulsive bleeding	1 (0.03)	0	1 (0.03)

Table 3 Intraoperative complications during cataract surgery in all simple cases and in simple cases for resident trainees and staff surgeons n (%)

Complication	Simple cases (n=2675)	Resident trainee (n=217)	Staff surgeon (n=2458)
Posterior capsule tear	66 (2.47)	15 (6.91)	51 (2.07)
Without vitreous loss	26 (0.97)	5 (2.30)	21 (0.85)
With vitreous loss	40 (1.50)	10 (4.61)	30 (1.22)
With dropped nucleus	13 (0.49)	5 (2.30)	8 (0.33)
Anterior capsule tear	37 (1.38)	12 (5.53)	25 (1.02)
Zonular fiber loss	26 (0.97)	6 (2.76)	20 (0.81)
Intraocular lens dislocation	1 (0.04)	0	1 (0.04)

and that of Oliveira-Ferreira *et al*^[6] found significantly higher complication rates among residents during phaco surgery. Differences may be explained by the different numbers of phaco surgeries performed by residents during the residency program in different countries, because increased resident experience seems to decrease the incidence of intraoperative complications.

Phaco surgery is a cornerstone of the residency training worldwide^[21]. While only 7.3% of all phaco surgeries involved residents in Hungary, studies from other industrialized countries reported much higher resident involvement rates (21%-64%)^[1,4-5,22]. Our institution is the biggest and leading

ophthalmic center in Hungary, and about 4 new residents begin their residency training every year in the clinic. The ophthalmology residency lasts for 5y and phaco surgery training begins in the second year. During the entire residency training, every resident performs 50 to 150 phaco surgeries at our institution, and this number may be associated with the lesser surgical experience compared to that in Canada, United Kingdom and Portugal where every resident performs 320 to 400 phaco surgeries on average during the same period^[5-6,23]. To ensure patient safety, specialists are allowed to swap the operating position with the resident during the surgery, in case of intraoperative complication or before predictable complication(s).

In the present study, the order and incidence of the most notable intraoperative complications were similar to findings from other studies as follows: PCT (2.6%), ACT (1.53%), zonular fiber loss (1.38%), and dropped nucleus (0.4%)^[4-6]. The incidence of PCT (2.3%) and that of dropped nucleus among specialists (0.3%) were also similar to data from Canada and Portugal^[5-6]. The incidence of ACT (5.81%) and PCT (6.22%) in residents was higher in our sample compared to that reported by Oliveira-Ferreira *et al*^[6] from Portugal (ACT: 1.0%; PCT: 3.4%), Corey and Olson^[24] and Bhagat *et al*^[25] from the USA (PCT: 2.0% and 6.7%), and Low *et al*^[5] from Canada (PCT: 0.8%). Dropped nucleus occurred also more frequently among residents in Hungary (2.0%) than in Germany (1.2%)^[19], Portugal (0.6%)^[6], and in the USA (0.6%)^[26]. PCT and vitrectomy due to dropped nucleus are considered as a benchmark intraoperative complication^[27-28], because they are associated with a higher incidence of postoperative endophthalmitis (8×) and retinal detachment (42×)^[29].

The intraoperative complication rate also depends on case complexity^[18]. Al-Jindan *et al*^[30] reported that the complication rate may be twofold in complex cases, compared to that in simplex cases. To reduce the effect of complex cases on complication rates, we also analyzed the intraoperative complication rates in simple cases. The incidence rates showed similar values across the entire sample and compared to other studies with one exception, where the incidence of PCT among residents also showed a higher value (6.9%) as in the whole sample.

The most difficult steps of the phaco surgery, where the specialist took over the operation from the resident, were phaco (60.0%), capsulorhexis (19.1%), irrigation/aspiration (11.8%), and hydrodissection (8.2%). The difficulty of each stage of phaco surgery is of great interest. Knowing which part of the surgery poses the greatest complexity for residents would be useful to design training methods alongside to enhance the practice of those critical steps. Several authors subjectively evaluated the difficulty of each stage of phaco surgery among residents. Based on their results and similar to our results,

residents found phaco, capsulorhexis, and irrigation/aspiration to be the most challenging parts of the surgery^[9-10]. Based on the subjective and objective assessment of phaco surgery difficulties and the incidence of different complication rates among residents, phaco and capsulorhexis may be considered the most challenging steps in phaco surgery for residents.

In our curriculum, the number of phaco surgeries performed by residents during the 5y of residency is lower compared to published data from other developed countries. This is because our department places emphasis on theoretical knowledge prior to surgical skill in the first part of the training, after which the resident begins to perform a higher number of surgeries. This difference in the curriculum explains the disparity in the number of surgeries performed by specialists and residents.

The limitations of our study include its retrospective design, its involvement of only a single center, and the non-randomization of patients.

In conclusion, intraoperative complication rates were higher in residents than in specialists. Resident involvement into phaco surgery should be increased in our department in Hungary, in order to improve surgical confidence and acquire safe phaco techniques until the end of the residency. Objective assessment of difficulty stages in phaco surgery was in line with the subjective measurement of difficulty levels reported by other surveys, with the most challenging parts of phaco surgery being phaco and capsulorhexis.

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REFERENCES

- 1 Pingree MF, Crandall AS, Olson RJ. Cataract surgery complications in 1 year at an academic institution. *J Cataract Refract Surg* 1999;25(5):705-708.
- 2 Randleman JB, Srivastava SK, Aaron MM. Phacoemulsification with topical anesthesia performed by resident surgeons. *J Cataract Refract Surg* 2004;30(1):149-154.
- 3 Ünal M, Yücel I, Sarıcı A, Artunay Ö, Devranoglu K, Akar Y, Altın M. Phacoemulsification with topical anesthesia: Resident experience. *J Cataract Refract Surg* 2006;32(8):1361-1365.
- 4 Fong CSU, Mitchell P, de Loryn T, Rochtchina E, Hong T, Cugati S, Wang JJ. Long-term outcomes of phacoemulsification cataract surgery performed by trainees and consultants in an Australian cohort. *Clin Exp Ophthalmol* 2012;40(6):597-603.
- 5 Low SAW, Braga-Mele R, Yan DB, El-Defrawy S. Intraoperative complication rates in cataract surgery performed by ophthalmology

- resident trainees compared to staff surgeons in a Canadian academic center. *J Cataract Refract Surg* 2018;44(11):1344-1349.
- 6 Oliveira-Ferreira C, Leuzinger-Dias M, Tavares Ferreira J, Macedo JP, Falcão-Reis F. Cataract phacoemulsification performed by resident trainees and staff surgeons: intraoperative complications and early postoperative intraocular pressure elevation. *J Cataract Refract Surg* 2020;46(4):555-561.
- 7 Gan KD, Rudnisky CJ, Weis E. Discussing resident participation in cataract surgery. *Can J Ophthalmol* 2009;44(6):651-654.
- 8 Nguyen TN, Silver D, Arthurs B. Consent to cataract surgery performed by residents. *Can J Ophthalmol* 2005;40(1):34-37.
- 9 Sen S, Patil M, Saxena R, Kumar A, Amar SP, Das D, Brar AS, Saini P. Perceived difficulties and complications in learners of phacoemulsification: a principal component analysis model. *Indian J Ophthalmol* 2019;67(2):213-216.
- 10 Dooley IJ, O'Brien PD. Subjective difficulty of each stage of phacoemulsification cataract surgery performed by basic surgical trainees. *J Cataract Refract Surg* 2006;32(4):604-608.
- 11 Sándor GL, Tóth G, Szabó D, Szalai I, Lukács R, Pék A, Tóth GZ, Papp A, Nagy ZZ, Limburg H, Németh J. Cataract blindness in Hungary. *Int J Ophthalmol* 2020;13(3):438-444.
- 12 Pék A, Szabó D, Sándor GL, Tóth G, Papp A, Nagy ZZ, Limburg H, Németh J. Relationship between diabetes mellitus and cataract in Hungary. *Int J Ophthalmol* 2020;13(5):788-793.
- 13 Zetterberg M, Kugelberg M, Nilsson I, Lundström M, Behndig A, Montan P. A composite risk score for capsule complications based on data from the Swedish national cataract register: relation to surgery volumes. *Ophthalmology* 2021;128(3):364-371.
- 14 Hashemi H, Pakzad R, Yekta A, Aghamirsalim M, Pakbin M, Ramin S, Khabazkhoob M. Global and regional prevalence of age-related cataract: a comprehensive systematic review and meta-analysis. *Eye (Lond)* 2020;34(8):1357-1370.
- 15 Swampillai AJ, Nowak VA, Maubon L, Neffendorf JE, Sahota D, Williams O, Lakhani B, Soare C, Sychev I, Ridyard E, Patel PJ, Park JC; Ophthalmology Trainee Clinical Research Network. Confidence of UK Ophthalmology Registrars in Managing Posterior Capsular Rupture: Results from a National Trainee Survey. *Ophthalmol Ther* 2022;11(1):225-237.
- 16 Szabó D, Sándor GL, Tóth G, Pék A, Lukács R, Szalai I, Tóth GZ, Papp A, Nagy ZZ, Limburg H, Németh J. Visual impairment and blindness in Hungary. *Acta Ophthalmol* 2018;96(2):168-173.
- 17 Jakobsson G, Montan P, Zetterberg M, Stenevi U, Behndig A, Lundström M. Capsule complication during cataract surgery: Retinal detachment after cataract surgery with capsule complication: Swedish Capsule Rupture Study Group report 4. *J Cataract Refract Surg* 2009;35(10):1699-1705.
- 18 Hård Af Segerstad P. Risk model for intraoperative complication during cataract surgery based on data from 900 000 eyes: previous intravitreal injection is a risk factor. *Br J Ophthalmol* 2021;2021:22:bjophtha2020-318645.
- 19 Briszi A, Prahs P, Hillenkamp J, Helbig H, Herrmann W. Complication rate and risk factors for intraoperative complications in resident-performed phacoemulsification surgery. *Graefes Arch Clin Exp Ophthalmol* 2012;250(9):1315-1320.
- 20 Ellis EM, Lee JE, Saunders L, Haw WW, Granet DB, Heichel CW. Complication rates of resident-performed cataract surgery: impact of early introduction of cataract surgery training. *J Cataract Refract Surg* 2018;44(9):1109-1115.
- 21 Rutar T, Porco TC, Naseri A. Risk factors for intraoperative complications in resident-performed phacoemulsification surgery. *Ophthalmology* 2009;116(3):431-436.
- 22 Muhtaseb M, Kalhor A, Ionides A. A system for preoperative stratification of cataract patients according to risk of intraoperative complications: a prospective analysis of 1441 cases. *Br J Ophthalmol* 2004;88(10):1242-1246.
- 23 Dean WH, Grant S, McHugh J, Bowes O, Spencer F. Ophthalmology specialist trainee survey in the United Kingdom. *Eye (Lond)* 2019;33(6):917-924.
- 24 Corey RP, Olson RJ. Surgical outcomes of cataract extractions performed by residents using phacoemulsification. *J Cataract Refract Surg* 1998;24(1):66-72.
- 25 Bhagat N, Nissirios N, Potdevin L, Chung J, Lama P, Zarbin MA, Fechtner R, Guo S, Chu D, Langer P. Complications in resident-performed phacoemulsification cataract surgery at New Jersey Medical School. *Br J Ophthalmol* 2007;91(10):1315-1317.
- 26 Clarke C, Ali SF, Murri M, Patel SN, Wang L, Tuft M, Weikert MP, Al-Mohtaseb Z. Outcomes and complication rates of primary resident-performed cataract surgeries at a large tertiary-care County hospital. *J Cataract Refract Surg* 2017;43(12):1563-1570.
- 27 Narendran N, Jaycock P, Johnston RL, Taylor H, Adams M, Tole DM, Asaria RH, Galloway P, Sparrow JM. The Cataract National Dataset electronic multicentre audit of 55, 567 operations: risk stratification for posterior capsule rupture and vitreous loss. *Eye (Lond)* 2009;23(1):31-37.
- 28 Lundström M, Dickman M, Henry Y, Manning S, Rosen P, Tassignon MJ, Young D, Stenevi U. Risk factors for dropped nucleus in cataract surgery as reflected by the European Registry of Quality Outcomes for Cataract and Refractive Surgery. *J Cataract Refract Surg* 2020;46(2):287-292.
- 29 Ferris JD, Donachie PH, Johnston RL, Barnes B, Olaitan M, Sparrow JM. Royal College of Ophthalmologists' National Ophthalmology Database study of cataract surgery: report 6. The impact of EyeSi virtual reality training on complications rates of cataract surgery performed by first and second year trainees. *Br J Ophthalmol* 2020;104(3):324-329.
- 30 Al-Jindan M, Almarshood A, Yassin SA, Alarfaj K, Al Mahmood A, Sulaimani NM. Assessment of learning curve in phacoemulsification surgery among the eastern Province ophthalmology program residents. *Clin Ophthalmol* 2020;14:113-118.