Original Article

Risk factors for posterior capsule rupture in mature cataract surgery: A study of 1302 cases

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Purpose: To identify the risk factors predisposing posterior capsule rupture (PCR) during mature cataract surgery. **Methods:** A total of 1302 consecutive mature cataract cases were included in this retrospective study. A detailed examination was performed for each patient and risk factors including age, gender, systemic diseases, ocular comorbidities, surgeon, and surgery method were recorded. Cases with PCR during surgery were classified as complicated. Multivariate logistic regression analysis with a generalized estimating equations method was applied for statistical analysis. **Results:** The overall rate of PCR was 7.30% (n=95 eyes). After adjusting for confounders, factors that remained significant on multivariate analysis were strabismus (odds ratio [OR]: 5.70, 95% confidence interval [CI]: 2.17–14.97; $P < 0.001$), phacodonesis (OR: 4.62, 95% CI: 2.59–8.22; $P < 0.001$), history of trauma (OR: 4.46, 95% CI: 1.64–12.12; $P = 0.003$), surgery method (extracapsular cataract extraction/phacoemulsification) (OR: 2.61, 95% CI: 1.60–4.26; $P < 0.001$), and pseudoexfoliation (OR: 1.94, 95% CI: 1.20–3.16; $P = 0.007$). **Conclusion:** Strabismus, phacodonesis, history of trauma, extracapsular cataract extraction method, and pseudoexfoliation were found to be important risk factors for developing PCR. Appropriate preoperative and perioperative precautions for these higher-risk cases can reduce complications.

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Cataract surgery is the most common intraocular surgery performed worldwide and has advanced technically in recent years. However, as in all surgeries, complications continue depending on the surgeon, surgical technique, and patient. In order to reduce the complications in cataract surgery, many studies have been carried out to detect ocular and systemic risk factors and to take precautions against them.[1-12]

One of the major complications of cataract surgery is posterior capsule rupture (PCR). Various risk factors have been identified for PCR. Local factors include sunken globe, narrow palpebral fissures, high myopia, glaucoma, shallow anterior chamber, pseudoexfoliation, use of doxazosin (α-blocker), floppy iris syndrome, zonulopathy, small pupil, small capsulorhexis, pseudoexfoliation, traumatic cataract, dense cataract, posterior polar cataract, poor fundus appearance/vitreous opacities, previous pars plana vitrectomy surgery, and a history of vitreous loss in the other eye.[1-12] As for the systemic risk factors, advanced age, dementia, disorientation, severe obesity, inability to lie flat, Marfan syndrome, diabetes mellitus, and systemic hypertension have been described.[1-3,6-11] Insufficient experience of the surgeon has also been shown to be one of the predisposing factors associated with vitreous loss.[1,2,5-8]

In addition, the risk of PCR increases in mature cataract surgery compared to normal cataract surgeries due to the absence of retroillumination, the fragile capsule, the obstruction of vision by liquefied cortical material, and the weak zonules.[3-7,9,10,13] To our best knowledge, no publication has directly addressed the risk factors for PCR in mature cataract surgery. In this study, we aimed to determine the factors increasing the risk of PCR for mature cataract surgery in a single tertiary referral eye hospital. Identifying the risks and taking necessary precautions may help reduce surgical complications.

Methods

This retrospective study was approved by the local ethics committee. The tenets of the Declaration of Helsinki were followed. This study was conducted with adult patients diagnosed with mature cataract and undergoing cataract surgery at an eye clinic of a tertiary referral hospital between January 2013 and December 2020. The preoperative examination findings and surgery notes of the patients were scanned. One thousand three hundred two eyes with mature cataract were enrolled. All patients were of Caucasian origin. Regardless of its etiology, mature cataract was defined as a completely opacified lens (white and/

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or brunescent cataract) that prevented the red reflex from being visualized.

Preoperative age, gender, history of systemic diseases including hypertension, diabetes mellitus, cardiac disease (coronary artery disease, coronary artery bypass graft, or stent), chronic respiratory disease (asthma or chronic obstructive pulmonary disease), benign prostatic hyperplasia, history of intraocular surgery, and routine ophthalmologic examination findings of all cases were recorded. The preoperative vision of all patients was at the level of hand motion, or light perception. In the slit-lamp examination, pterygium, corneal scarring in the 6-mm central cornea, cornea guttata, leukoma adherence, posterior synechia, pseudoexfoliative material, presence of small pupil (pupil diameter ≤6 mm despite maximal pharmacologic dilation), presence of phacodonesis, degenerative disease of the vitreous (asteroid hyalosis, synchysis scintillans), and diabetic retinopathy in any eye were noted. Also, the risk factors were evaluated, including manifest sunken globe, strabismus (exotropia or esotropia >10 prism diopters misalignment), and history of trauma, glaucoma, and vitrectomy. Anterior chamber depth (ACD) was measured 3 times by optical low coherence reflectometry (LenStar LS 900; Haag-Streit AG, Switzerland). Axial length (AL) of eyes was assessed 10 times by using a 11-MHz probe of A-scan ultrasonography (Compact Touch; Quantel Medical, France) with applanation after instillation of proparacaine hydrochloride 0.5% (Alcaine; Alcon-Couvreur, Puurs, Belgium). The mean values of these measurements were retrieved from the patients' medical records. Cases of surgery combined with cataract (such as trabeculectomy, vitrectomy), phacomorphic glaucoma, and phacolytic glaucoma were excluded from the study. The degree of expertise (resident, fellow) of the operating surgeon, the type of cataract surgery (phacoemulsification/extracapsular cataract extraction [ECCE]), and the results of the surgery were evaluated. Topical cyclopentolate hydrochloride 1% (Siklopleji n®; Abdi İbrahim, İstanbul, Turkey) and tropicamide 1% (Tropamid®; Bilim İlaç, İstanbul, Turkey) drops were instilled preoperatively for pupil dilation. All surgeries were performed under local anesthesia (subconjunctival or subtenon anesthesia). Trypan blue was injected into the anterior chamber under an air bubble to make the capsule visible before capsulorhexis. In 10 (0.8%) of 1302 operations, the phacoemulsification method was converted to the ECCE method due to PCR. In the comparison of these two methods, converted surgeries following PCR were classified in the phacoemulsification group. Risk factors were determined according to whether PCR developed during the surgery or not. The eyes were classified as complicated and uncomplicated groups according to the occurrence of PCR during the surgery.

Statistical analysis

Descriptive data were given as mean ± standard deviation values. After determining that the data showed normal distribution, parametric analysis methods were used. Chi-square test was used in the analysis of categorical variables. Dichotomization was applied to the eyes with a value of 2.5 mm for ACD and 26 mm for AL. Independent sample *t*-test was used to determine whether there was a difference in the age of the patients in terms of categorical variables. Final potential risk factors on the development of PCR were identified using multivariate regression analysis. Multivariate logistic regression analyses were performed to estimate the adjusted odds ratio (OR) and 95% confidence interval (CI). Statistical significance was accepted as *P* value less than 0.05. The statistical data of the study were analyzed using the Statistical Package for the Social Sciences (SPSS) 22.0 (SPSS, Chicago, IL, USA) program.

Results

Data of 1302 eyes of 1226 patients with mature cataract were included in the analysis. The mean age of the patients was 66.09 ± 12.80 (range, 18–101) years. The phacoemulsification method was performed in 1086 (83.4%) cases and the ECCE method in 216 (16.6%) cases. Of 1302 cases, 338 (26%) were operated by resident surgeons and 964 (74%) were operated by fellow physicians. PCR occurred in 95 (7.30%) of 1302 eyes. Iris retractor was used in 47 (3.6%) cases, and a capsule tension ring was used in 46 (3.5%) operations. In 29 cases (2.2%), intraocular lens could not be implanted.

The systemic characteristics of the complicated and uncomplicated groups are shown in Table 1. Also, the groups were compared in terms of risk factors and these are summarized in Table 2. Age was statistically different between the groups ($P < 0.001$). Gender and systemic diseases were not significantly different ($P > 0.05$). There was a statistically significant difference in the history of trauma, history of glaucoma, strabismus, pseudoexfoliation, small pupil, phacodonesis, and surgery type ($P < 0.05$). History of vitrectomy, laterality of eye, sunken glob, pterygium, corneal scar, cornea guttata, leukoma adherence, posterior synechia, vitreous disease, diabetic retinopathy, ≤2.5 mm ACD, ≥26 mm AL, and surgeon parameters were similar ($P > 0.05$).

Among the risk factors for PCR in all cases, the presence of pseudoexfoliation was found to be the most common (25.7%). Of the 30 total strabismus patients, 17 had exotropia and 13 had esotropia, and the PCR rates were similar (3/17 [17.6%] vs. 4/13 [30.8%], $P = 0.400$). The rate of preferred ECCE/phacoemulsification surgery was found to be statistically higher in residents than expert physicians (107/231 [31.7%] vs. 109/855 [11.3%] respectively, $P < 0.001$). The PCR rate in the ECCE method was lower in residents than expert physicians, but the result was not statistically significant (13.1% vs. 21.1%, respectively, $P = 0.118$). The PCR rate in phacoemulsification surgery was similar between residents and expert physicians (5.6% vs. 5.3%, respectively, $P = 0.827$). History of trauma and strabismus was more common in younger patients, while history of glaucoma, pseudoexfoliation, small pupil, phacodonesis, and ECCE/phacoemulsification method emerged in older patients ($P < 0.05$).

The overall correctness of the multiple logistic regression analysis model was 93%, and the result of Hosmer and Lemeshow goodness of fit was $P = 0.942$. The adjusted OR for strabismus was 5.70 (95% CI, 2.17–14.97, $P < 0.001$), the adjusted OR for phacodonesis was 4.62 (95% CI, 2.59–8.22, $P < 0.001$), the adjusted OR for history of trauma was 4.46 (95% CI, 1.64–12.12, $P = 0.003$), the adjusted OR for surgery (ECCE/phacoemulsification) was 2.61 (95% CI, 1.60–4.26, $P < 0.001$), and the adjusted OR for pseudoexfoliation was 1.94 (95% CI, 1.20–3.16, $P = 0.007$). Age, glaucoma, and small pupil were not strongly associated with PCR complication according to multivariate analysis ($P > 0.05$). The results of the multiple logistic regression analysis are presented in Table 3.

Table 1: Association between posterior capsule ruptures and systemic characteristics

Characteristic	Complicated (*n*=95)	Uncomplicated (*n*=1207)	*P*
Mean age (years)±SD	70.69±11.79	65.71±12.81	<0.001*
Gender			
Male, *n* (%)	50 (52.6%)	643 (53.3%)	0.904
Female, *n* (%)	45 (47.4%)	564 (46.7%)	
Hypertension, *n* (%)	38 (40%)	420 (34.8%)	0.307
Diabetes mellitus, *n* (%)	13 (13.7%)	214 (17.7%)	0.317
Cardiac disease, *n* (%)	6 (6.3%)	121 (10%)	0.241
Chronic respiratory disease, *n* (%)	7 (7.4%)	61 (5.1%)	0.329
Benign prostatic hyperplasia in men, *n* (%)	1 (2%)	19 (3%)	0.698

SD=standard deviation. *Statistically significant difference (*P*<0.05)

Table 2: Association between posterior capsule ruptures and ophthalmologic characteristics

Characteristic	Complicated (*n*=95)	Uncomplicated (*n*=1207)	*P*
History of trauma, *n* (%)	7 (7.4%)	28 (2.3%)	0.003*
History of glaucoma, *n* (%)	13 (13.7%)	69 (5.7%)	0.002*
History of vitrectomy, *n* (%)	0 (0%)	8 (0.7%)	0.426
Eye laterality			
Right eye, *n* (%)	51 (53.7%)	598 (49.5%)	0.437
Left eye, *n* (%)	44 (46.3%)	609 (50.5%)	
Sunken globe, *n* (%)	3 (3.2%)	44 (3.6%)	0.806
Strabismus, *n* (%)	7 (7.4%)	23 (1.9%)	0.001*
Pterygium, *n* (%)	7 (7.4%)	48 (4%)	0.114
Corneal scar, *n* (%)	3 (3.2%)	27 (2.2%)	0.565
Cornea guttata, *n* (%)	1 (1.1%)	10 (0.8%)	0.818
Leukoma adherence, *n* (%)	0 (0%)	4 (0.3%)	0.574
Posterior synechia, *n* (%)	0 (0%)	12 (1%)	0.329
Pseudoexfoliation, *n* (%)	46 (48.4%)	288 (23.9%)	<0.001*
Small pupil, *n* (%)	12 (12.6%)	77 (6.4%)	0.020*
Phacodonesis, *n* (%)	25 (26.3%)	56 (4.6%)	<0.001*
Vitreous disease, *n* (%)	1 (1.1%)	8 (0.7%)	0.659
Diabetic retinopathy, *n* (%)	3 (3.2%)	45 (3.7%)	0.776
Mean ACD (mm)±SD	3.05±0.48	3.07±0.47	0.735
Mean AL (mm)±SD	23.62±1.38	23.39±1.45	0.127
≤2.5 mm ACD, *n* (%)	11 (11.6%)	135 (11.2%)	0.907
≥26 mm AL, *n* (%)	5 (5.3%)	40 (3.3%)	0.317
Surgeon			
Resident, *n* (%)	27 (28.4%)	311 (25.8%)	0.570
Fellow, *n* (%)	68 (71.6%)	896 (74.2%)	
Surgery			
ECCE, *n* (%)	37 (38.9%)	179 (14.8%)	<0.001*
Phacoemulsification, *n* (%)	58 (61.1%)	1028 (85.2%)	

ACD=anterior chamber depth, AL=axial length, ECCE=extracapsular cataract extraction, SD=standard deviation. *Statistically significant difference (*P*<0.05)

Discussion

Phacoemulsification has become the preferred procedure in cataract surgery as it requires a small incision and working in a closed system, resulting in a low complication rate, faster visual rehabilitation, and less astigmatism.[11,14,15] However, alternative techniques to phacoemulsification may be preferred due to high cost of equipment and consumables, dependency on technical assistance, and complexity of cases (hypermature cataracts with corneal opacities, zonular instability, and insufficient pupil dilation).[16] Besides, phacoemulsification may have to be converted to extracapsular cataract surgery due to incorrect continuous curvilinear capsulorhexis, insufficient mydriasis, extremely hard cataract, recognition of subluxated lens, or PCR.[2,11,15] Although the ECCE method is rarely used today, this method is used in patients with mature cataracts under the supervision of a specialist in assistant training in our hospital. In our study, the results of both methods were examined and compared. In accordance with the literature, PCR occurred more frequently in the ECCE group than in the phacoemulsification group.[11,15]

Table 3: Multivariate logistic regression analysis of the association between posterior capsule ruptures and clinical characteristics

Characteristic	Exp β (odds ratio)	95% Limit of agreement for the odds ratio	*P*
Age	0.98	0.96-1.00	0.062
History of trauma	4.46	1.64-12.12	0.003*
History of glaucoma	1.76	0.88-3.51	0.111
Strabismus	5.70	2.17-14.97	<0.001*
Pseudoexfoliation	1.94	1.20-3.16	0.007*
Small pupil	1.87	0.94-3.74	0.076
Phacodonesis	4.62	2.59-8.22	<0.001*
Surgery (ECCE/ phacoemulsification)	2.61	1.60-4.26	<0.001*

ECCE=extracapsular cataract extraction. *Statistically significant difference (*P*<0.05)

PCR rates were found to be high in advanced age in many studies.[1,3,6,17,18] According to multivariate analysis, age parameter in our study was similar to that of some studies.[8,11] Accidental head movements, systemic conditions such as dementia, disorientation, hearing loss, and local comorbidities such as glaucoma, pseudoexfoliation, small pupil, and harder nucleus have been reported to increase with aging.[2,19,20] In our study, we discerned trauma history and strabismus factors in younger patients and observed history of glaucoma, pseudoexfoliation, small pupil, phacodonesis, and ECCE method in elderly patients. The effect of aging can be explained by coexisting conditions that increase the likelihood of PCR.

Some studies have emphasized that male[6,7] or female[1] gender increases the risk of PCR. These different results between genders have been obtained with different effects on the cardiovascular system due to hormonal factors, personality structure, and the effects of α-blockers.[1,6,7] However, we ascertained no difference similar to several other studies.[3,5,8,11]

Diabetes mellitus was suggested as a risk factor that increases the PCR by some mechanisms such as previous pars plana vitrectomy and rigid pupil.[1] However, many studies did not show any difference.[1,3,7,8] There is no consensus on whether diabetic retinopathy increases the PCR rate[6,7,9] or not.[1,3,10] In this study, we did not observe any difference in terms of the presence of both diabetes mellitus and diabetic retinopathy.

Abbasoğlu *et al*.[8] reported an increase in the PCR rate due to a decrease in the effectiveness of the drug, since they performed local anesthesia without adrenaline in hypertensive patients. On the other hand, some studies did not report any difference.[1,10] Similar to the report of Ergun *et al*.,[7] we found no association between coronary artery disease, asthma, and PCR. Since the eye is a relatively localized organ and operations are performed under local anesthesia, it may not be directly affected by systemic factors.

Extraocular risk factors are often associated with problematic access to the surgical site due to physical limitations and/or limited visibility of the operative field. This includes sunken globe and ocular surface obstacles (pterygium, corneal scar, cornea guttata). Segers *et al*.[9] proposed that corneal opacities are associated with PCR. However, our findings agree with those of other studies stating that there was no difference.[3-5,10]

Interestingly, to the best of our knowledge, studies investigating the risks of cataract surgery in the literature did not evaluate the strabismus factor. Patients with strabismus were the riskiest group in mature cataract surgery in our study. This may be related to the decrease in the visual clarity of the surgical field and the inability to maintain a safe distance due to deviation of the eye. The limitation of movement in the extraocular muscles may also contribute to the susceptibility to PCR. Our hospital is a center where many patients are referred from rural areas in our country and untreated patients for strabismus are relatively common. In squint eyes, operating the cataract before it becomes mature may reduce the PCR rate. Increasing awareness to refer these patients earlier may improve surgical outcomes.

In the patients having leukoma adherence and posterior synechia, increased capsule and zonular fragility can cause complications like zonular dialysis and vitreous loss during phacoemulsification. However, the risk of PCR did not increase in our series and in the study of Artzén *et al*.[5] This result may be related to the fact that such rare challenging cases are performed by more experienced surgeons or that the surgeon is more careful.

Glaucoma has been cited as a greater contributing factor to PCR.[6,8] This is not an unexpected finding, given the relatively narrow margin of safety for capsular bag integrity in many surgeries, weaker zonules and poor pupillary dilation in concomitant pseudoexfoliation, and susceptibility to poor dilation with chronic use of miotics. However, as with some studies, we did not find greater PCR trends in eyes with history of glaucoma in this study.[3,10] Cataract surgery after intraocular pressure control under antiglaucomatous treatment in our hospital may contribute to this situation.

Pseudoexfoliation syndrome is known to be an important and common risk factor for capsular complications in cataract surgery.[1,4,6,8,10,12,21] The risk increases through a variety of mechanisms, including poor pupil dilation and increased capsule and zonular fragility.[1,21] In the present study, we found higher tendency toward PCR in eyes with pseudoexfoliation syndrome than in those without.

Presence of a small pupil is a well-known challenge in cataract surgery.[1,5-7,12,18] Inadequate mydriasis results in increased complication rates as it limits vision and makes capsulorhexis, phacoemulsification, and irrigation/aspiration manipulations difficult. However, some studies did not show any difference.[4,10] In such cases, intracameral adrenaline injection, stretch pupilloplasty, and iris retractors may facilitate the surgery. The lack of statistically significant probability of PCR may be due to technical modifications and proactive pupil management strategies (such as iris retractor insertion).

Zonular pathology leads to PCR via anterior movement and increased curvature of the lens. In line with previous studies, cases with phacodonesis presented with high rates of PCR in our hospital.[3-6,12] Also, trauma history is a common cause of PCR.[3,5,8] Eyes with trauma are more prone to capsular or zonular ruptures and more vulnerable to complications due to this defect. As expected from previous similar studies,[3,5,8] we determined trauma history as a contributing factor to PCR.

Prior vitrectomy may be complicated through loose zonules, unstable posterior capsules, and posterior capsule plate.[3,22] Also, PCR can occur during hydrodissection due to posterior lenticular touch during vitrectomy.[23] The current study corresponds to a study by Rutar *et al*.[4] that found no difference.

Asteroid hyalosis or synchysis scintillans can make the posterior capsule less visible during phacoemulsification. In these eyes, it is recommended to stay away from the posterior capsule during surgery.[2,6] We observed that the PCR ratio was similar in these eyes. Similar rate may be related to the adoption of these precautions.

PCR rates have been reported to be high in cases with an ACD of 2.5 mm or less.[7,12,24] In the shallow anterior chamber, iris prolapse is more common and the posterior capsule is closer to the phaco instrument. However, some studies did not show any difference for a shallow anterior chamber.[1,3,4,8] Long AL has been expressed as prone to complications. Long AL may affect the anterior chamber stability. Also, trampolining of the posterior capsule and vitreous liquefaction/degeneration are more likely. An AL of 26 mm or more has been associated with PCR.[1,5,6] However, some studies did not find any association.[3,8] In our study, there was no significant relationship between ocular dimensions and ACD and PCR.

Another important factor affecting the incidence of PCR with cataract surgery in the literature, which ranges from 0.2% to 17%, is surgical experience.[1,2,4-12,14,15,25,26] Various studies have also shown a reduction in complication rates proportional to resident experience.[27,28] On the other hand, some studies did not declare any difference.[3,4] Similar PCR rate in our study can be attributed to the fact that residents perform the surgery under close supervision by experienced physicians, especially the ECCE surgeries.

Main limitation of our research is its retrospective nature. The lack of mention of patient cooperation in the surgical records is a missing aspect. Not categorizing the findings according to the years of expertise or the number of cases of the surgeons is one of the shortcomings of our study. The lack of PCR rates belonging to different races other than those of Caucasian origin may be a limitation. However, the fact that this is a large series of mature cataracts and a comprehensive evaluation of risk factors are the strengths of the study.

Conclusion

In conclusion, particularly challenging cases with strabismus, phacodonesis, history of trauma, ECCE method, and pseudoexfoliation were found to be most strongly associated with PCR in this study. Faster recovery can be achieved by earlier planning of cataract surgery and taking preoperative and perioperative precautions in patients with mature cataract.

Patient consent for publication

Obtained.

Ethics approval

The study was approved by the Institutional Review Board/ Ethics Committee of Ankara Training and Research Hospital, Ankara, Turkey (protocol no: E-20-461). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Conflicts of interest

There are no conflicts of interest.

References

1. Zare M, Javadi M, Einollahi B, Baradaran-Rafii AR, Feizi S, Kiavash V. Risk factors for posterior capsule rupture and vitreous loss during phacoemulsification. J Ophthalmic Vis Res 2009;4:208-12.
2. Chakrabarti A, Nazm N. Posterior capsular rent: Prevention and management. Indian J Ophthalmol 2017;65:1359-69.
3. Blomquist PH, Morales ME, Tong L, Ahn C. Risk factors for vitreous complications in resident-performed phacoemulsification surgery. J Cataract Refract Surg 2012;38:208-14.
4. Rutar T, Porco TC, Naseri A. Risk factors for intraoperative complications in resident-performed phacoemulsification surgery. Ophthalmology 2009;116:431-6.
5. Artzén D, Lundström M, Behndig A, Stenevi U, Lydahl E, Montan P. Capsule complication during cataract surgery: Case-control study of preoperative and intraoperative risk factors. Swedish Capsule Rupture Study Group report 2. J Cataract Refract Surg 2009;35:1688-93.
6. Narendran N, Jaycock P, Johnston RL, Taylor H, Adams M, Tole DM, *et al*. The Cataract National Dataset electronic multicentre audit of 55,567 operations: Risk stratification for posterior capsule rupture and vitreous loss. Eye (Lond) 2009;23:31-7.
7. Ergun ŞB, Kocamış Sİ, Çakmak HB, Çağıl N. The evaluation of the risk factors for capsular complications in phacoemulsification. Int Ophthalmol 2018;38:1851-61.
8. Abbasoğlu OE, Hoşal B, Tekeli O, Gürsel E. Risk factors for vitreous loss in cataract surgery. Eur J Ophthalmol 2000;10:227-32.
9. Segers MHM, Behndig A, van den Biggelaar FJHM, Brocato L, Henry YP, Nuijts RMMA, *et al*. Risk factors for posterior capsule rupture in cataract surgery as reflected in the European Registry of quality outcomes for cataract and refractive surgery. J Cataract Refract Surg 2022;48:51-5.
10. Clarke C, Ali SF, Murri M, Patel SN, Wang L, Tuft M, *et al*. Outcomes and complication rates of primary resident-performed cataract surgeries at a large tertiary-care county hospital. J Cataract Refract Surg 2017;43:1563-70.
11. Thanigasalam T, Reddy SC, Zaki RA. Factors associated with complications and postoperative visual outcomes of cataract surgery ; a study of 1, 632 cases. J Ophthalmic Vis Res 2015;10:375-84.
12. Chen M, Lamattina KC, Patrianakos T, Dwarakanathan S. Complication rate of posterior capsule rupture with vitreous loss during phacoemulsification at a Hawaiian cataract surgical center: A clinical audit. Clin Ophthalmol 2014;8:375-8.
13. Bayramlar H, Hepsen IF, Yilmaz H. Mature cataracts increase risk of capsular complications in manual small-incision cataract surgery of pseudoexfoliative eyes. Can J Ophthalmol 2007;42:46-50.
14. Cruz OA, Wallace GW, Gay CA, Matoba AY, Koch DD. Visual results and complications of phacoemulsification with intraocular lens implantation performed by ophthalmology residents. Ophthalmology 1992;99:448-52.
15. de Silva SR, Riaz Y, Evans JR. Phacoemulsification with posterior chamber intraocular lens versus extracapsular cataract extraction (ECCE) with posterior chamber intraocular lens for age-related cataract. Cochrane Database Syst Rev 2014;29:CD008812.

16. Signes-Soler I, Javaloy J, Muñoz G, Moya T, Montalbán R, Albarrán C. Safety and efficacy of the transition from extracapsular cataract extraction to manual small ıncision cataract surgery in prevention of blindness campaigns. Middle East Afr J Ophthalmol 2016;23:187-94.
17. Berler DK. Intraoperative complications during cataract surgery in the very old. Trans Am Ophthalmol Soc 2000;98:127-32.
18. Kim JY, Ali R, Cremers SL, Yun SC, Henderson BA. Incidence of intraoperative complications in cataract surgery performed by left-handed residents. J Cataract Refract Surg 2009;35:1019-25.
19. Wiener JM, Pazzaglia F. Ageing- and dementia-friendly design: theory and evidence from cognitive psychology, neuropsychology and environmental psychology can contribute to design guidelines that minimise spatial disorientation. Cogn Process 2021;22:715-30.
20. Drolsum L, Haaskjold E. The influence of age on characteristics of cataract patients. Acta Ophthalmol (Copenh) 1994;72:622-6.
21. Drolsum L, Haaskjold E, Sandvig K. Phacoemulsification in eyes with pseudoexfoliation. J Cataract Refract Surg 1998;24:787-92.
22. Pinter SM, Sugar A. Phacoemulsification in eyes with past pars plana vitrectomy: Case-control study. J Cataract Refract Surg 1999;25:556-61.
23. Asaria RHY, Wong SC, Sullivan PM. Risk for posterior capsule rupture after vitreoretinal surgery. J Cataract Refract Surg 2006;32:1068-9.
24. Küchle M, Viestenz A, Martus P, Händel A, Jünemann A, Naumann GO. Anterior chamber depth and complications during cataract surgery in eyes with pseudoexfoliation syndrome. Am J Ophthalmol 2000;129:281-5.
25. Hagan JC 3rd, Davison JA. Clinical comparison of the Alcon 20,000 legacy and 10,000 Master phacoemulsification units. J Cataract Refract Surg 1998;24:693-6.
26. Browning DJ, Cobo LM. Early experience in extracapsular cataract surgery by residents. Ophthalmology 1985;92:1647-53.
27. Tarbet KJ, Mamalis N, Theurer J, Jones BD, Olson RJ. Complications and results of phacoemulsification performed by residents. J Cataract Refract Surg 1995;21:661-5.
28. Corey RP, Olson RJ. Surgical outcomes of cataract extractions performed by residents using phacoemulsification. J Cataract Refract Surg 1998;24:66-72.