BJMS
Borneo Journal of Medical Sciences

ORIGINAL ARTICLE

Visual Acuity after Posterior Capsular Rupture during Cataract Surgery

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Received: 27 August 2018

Accepted: 19 March 2019

How to Cite:
Amin, N., Mohd Norizan, N. H., Raja Omar, R. N., Abd Jalil, N., & Mustapha, M. (2019). Visual acuity after posterior capsular rupture during cataract surgery. *Borneo Journal of Medical Sciences (BJMS)*, *13* (2), 15–24. Retrieved from https://jurcon.ums.edu.my/ojums/index.php/bjms/article/view/1266

Keywords: posterior capsular rupture, cataract surgery, visual outcome

ABSTRACT

Posterior capsular rupture (PCR) is a common and serious complication of cataract surgery. It complicates the process of inserting posterior chamber intraocular lens and affects the visual outcome. This study is a review on visual acuity of patients that had PCR during cataract surgery in Hospital Melaka, risk factors of PCR, and factors that cause poor visual outcome. The record of all patients that had PCR during cataract surgery from 1 January 2014 till 31 March 2017 was traced using National Eye Database (NED) and the patients' folders were reviewed retrospectively. Data collected was demographic data, type of cataract surgery, status of surgeon, underlying ocular diseases, risks factors for PCR, postoperative visual acuity, and factors that cause poor visual outcome. There were 238 eyes that had PCR during cataract surgery, from 126 (53%) female and 112 (47%) male patients. The mean age was 66.62 years old, ranging from 9 to 87 years old. Major risk factors identified were hard cataract, polar cataract, uncooperative patients, extended continuous capsulorhexis, subluxated lens, myopia, vitrectomised eyes, and poor pupil dilatation. From 153 cases that had no pre-existing ocular diseases, 119 (78%) cases had normal vision (best corrected visual acuity – BCVA) two months after surgery, 10 (7%) cases had moderate visual impairment, and four (2%) cases had severe visual impairment. Causes of BCVA poorer than 6/18 were high astigmatism, CMO, and prolonged inflammation. Cataract surgery, even complicated by PCR, is compatible with good visual outcome if the complications are managed promptly.

INTRODUCTION

Globally, prevalence of smoking is increasing Cataract remains the leading cause of visual impairment in Malaysia (58%) in spite of the progress made in improving surgical techniques in cataract surgeries[1]. Posterior capsular rupture (PCR) is a serious and most common complication of cataract surgery[2]. It complicates the process of inserting a posterior intraocular lens and affects the visual outcome[2]. An improperly managed PCR may lead to other complications, thus eventually causing poor visual outcome[3]. PCR can occur at any stage of cataract surgery[2].

Despite marked improvement in the safety of cataract surgery, diagnosing and managing PCR remain a challenge. Identification of pre-existing risk factors is important so that precautionary steps can be taken during surgery to prevent complications[3].

Certain predisposing factors that can be identified preoperatively are posterior polar cataract (with a pre-existing posterior capsular dehiscence), traumatic cataract, hypermature cataract, post-vitrectomy cataract, eyes with long axial length (with weak bag and weak zonules), eyes with short axial length (with crowded anterior chamber), and presence of pseudoexfoliation material (with weak bag, weak zonules, and poorly dilating pupil)[2-4].

Intraoperative factors may be poor visibility of posterior capsule due to deeply set eyes with prominent brow, fluid pooling, dense arcus, corneal scars, and small pupil (as in diabetic patients, post-uveitic posterior synechiae, pseudoexfoliation, traumatic cataracts, and senile pupillary rigidit[2 - 4]. Intraoperative events that may also lead to PCR are extension of radial tears of the anterior continuous curvilinear capsulorhexis through the capsular fornix into the posterior capsule, vigorous hydrodissection especially in incomplete rhexis in cases like posterior polar cataract, traumatic cataract, pseudoexfoliation cases and hypermature cataract. PCR also commonly occurs during removal of the last fragment of nucleus following a transient post-occlusion surge in phacoemulsification. Infrequently, PCR may occur during intraocular lens placement and dialing. Hydroprolapse of the nucleus or hooking out of the nucleus through a small rhexis can exert undue pressure on the posterior capsule (in small incision cataract surgery or extracapsular cataract extraction surgery). PCR can occur if there are a lot of manipulations in the bag and the anterior chamber is inadequately pressurized. When the anterior chamber keeps collapsing, there are high chances of the lax posterior capsule coming up and getting caught. PCR may also occur during polishing of the posterior capsule or if there is a direct hit by phacoemulsification probe, chopper, or dialer[2, 3].

PCR, with or without vitreous loss, may lead to increased incidence of hyphema, persistent postoperative inflammation, retained cortical matter, corneal oedema, corneal decompensation, postoperative endopthalmitis, cystoid macular oedema, worsening of diabetic retinopathy, and retinal detachment[2, 3]. Contact between vitreous strands and the corneal endothelium may lead to corneal decompensation[2, 5]. Incarcerated vitreous strands within the surgical wound may predispose to epithelial and fibrous ingrowth, as well as introduction of microorganisms into the eye which predispose to endopthalmitis[2]. Retinal traction by vitreous strands increases the risk of cystoid macular oedema and retinal detachment[2,5]. These postoperative complications may cause poor visual outcome. Once complication happens, appropriate management is important to maintain an excellent outcome. Hence, this study aims to review the best corrected visual acuity among patients that had PCR during cataract surgery, evaluate the risk factors of PCR, and review factors that cause poor visual outcome in Hospital Melaka.

MATERIAL AND METHODS

This retrospective study reviewed the records of all patients that had PCR during cataract surgery in Hospital Melaka from 1 January 2014 until 31 March 2017. Patients' data were obtained from National Eye Database (a web-based, password protected surveillance system that collects data on eye diseases and clinical performance of ophthalmology services in Malaysia). All data were recorded in standardized data collection form. Patients that defaulted follow up at two months post operation and patients with pre-existing ocular premorbidity such as retinopathy, glaucoma, chronic uveitis and history of previous ocular surgery were excluded in the analysis of best corrected postoperative visual acuity and in the review of the causes for poor visual outcome.

Data was collected by five domains, which were patient's demographic data, preoperative risk assessment of having PCR, intraoperative risk of having PCR, postoperative visual acuity, and postoperative complications.

Preoperative risk factors that were studied were age and gender, operated eye (right or left), presence of diabetes mellitus and systemic hypertension, surgeon's status, type of cataract surgery, preoperative visual acuity, premorbid ocular diseases, axial myopia, poor pupil dilatation, history of vitrectomy, pseudoexfoliation (PXM), and history of uveitis. The nature of cataract involved depended on the maturity and expected complications (e.g. hard, polar, intumescent, subluxated, traumatic, or congenital cataract).

In intraoperative domain, the surgeons' statuses were divided into consultant (more than five years of service as specialist), specialist (less than five years of service as specialist), gazetting specialist (new specialist under supervision), registrar (final year of post-graduate), and medical officer. Types of cataract surgeries done were phacoemulsification, extracapsular cataract extraction (ECCE), intracapsular cataract extraction (ICCE), small incision cataract surgery (SICS), and lens aspiration. Intraoperative risks of having PCR as mentioned previously were recorded. Stages where PCR was noticed and other complications such as zonulodialysis, corneal oedema, and dropped nucleus were recorded as well.

Best corrected visual acuity at two months postoperative period was recorded using Snellen chart and divided into good vision, moderate visual impairment, severe visual impairment, and blind (WHO classification). The patients' refractive status was analyzed and recorded. Other postoperative complications that lead to poor visual outcome were also analyzed and recorded.

Data was analyzed using IBM SPSS software version 20.0 with significance level of $p < 0.05$. This study was registered with National Medical Research Registry (NMRR) and the identification number is 17-1688-36337. This study was approved by the Medical Research and Ethics Committee and was supported by the Ministry of Health operational budget.

RESULTS

The patients' main characteristics are listed in Table 1. A total of 7713 eyes underwent cataract operation; 238 eyes had PCR (85 eyes with ocular premorbidity and 153 eyes without premorbidity). Incidence rate of PCR was 3.0% (1.10% with ocular premorbidity, 1.97% without ocular premorbidity). Possible risk factors of PCR were shown in Table 2 and the results showed that Malay race, diabetes mellitus, type of surgery, and surgeon status significantly increase the risk of getting PCR ($p < 0.05$).

Table 1 Characteristics of patients with and without Posterior Capsule Rupture (PCR)

Variables	**PCR** ***n*** **= number of eyes**	**No PCR** ***n*** **= number of eyes**
Age		
< 65 years old	89	3,198
≥ 65 years old	149	4,277
Laterality		
Right eye	127	3,803
Left eye	111	3,672
Gender		
Male	112	3,400
Female	126	4,075
Race		
Malay	140	3,736
Chinese	79	2,270
Indian	17	785
Others	2	686
Systemic illness		
Diabetes mellitus	146	3,747
Hypertension	160	4,809
Ischaemic heart disease	20	679
Type of surgery		
Phacoemulsification	165	6,902
ECCE	22	396
Lens Aspiration	3	66
Phaco converted to ECCE	48	61
Surgeon Status		
Consultant and Specialist	150	6,707
Gazetting Specialist	34	340
Medical Officer	54	428

Table 2 Distribution of risk factors of PCR and relative risk result

Variables	OR	95% Confidence Interval	*p*-Value
1. Age Group			
– Age more than 65 relative to age less than 65	1.25	0.959 – 1.634	0.098*
2. Gender			
– Male relative to Female	0.9	0.725 – 1.216	0.631*
3. Laterality			
– Right Eye relative to Left Eye	1.1	0.853 – 1.431	0.450*
4. Race			
– Malay relative to non-Malay	**1.4**	**1.100 – 1.818**	**0.007***
– Chinese relative to non-Chinese	1.2	0.866 – 1.499	0.351*
– Indian relative to non-Indian	0.6	0.389 – 1.080	0.095*
5. Systemic illness			
– DM relative to non-DM	**1.6**	**1.212 – 2.058**	**0.001***
– HPT relative to non-HPT	1.1	0.864 – 1.497	0.359*
– IHD relative to non-IHD	0.9	0.577 – 1.461	0.719*
6. Type of surgery			
ECCE relative to Phaco	**2.3**	**1.473 – 3.667**	**0.000***
Lens Aspiration relative to Phaco	**1.9**	**0.592 – 6.110**	**0.221****
Phaco converted to ECCE relative to Phaco	**32.9**	**21.878 – 49.522**	**0.000****
7. Surgeon Status			
Gazetting Specialist relative to Specialist or Consultant	**4.5**	**3.034 – 6.590**	**0.000***
Medical Officer relative to Specialist or Consultant	**5.6**	**4.072 – 7.816**	**0.000***

*Evaluation using Pearson Chi Square Test with significant level of $p < 0.05$
**Evaluation using Fisher's Exact Test with significant level of $p < 0.05$

Other risks factors that were identified in our study were lens-related glaucoma (1.7%), pre-existing diabetic retinopathy (17.6%), other types of glaucoma (4.2%), extended continuous capsulorhexis (11.3%), uncooperative patients (9.2%), traumatic cataract (2.5%), polar cataract (0.1%), intumescent cataract (1.3%), hard or mature cataract (21.4%), presence of pseudoexfoliation material (0.8%), post-vitrectomy cataract (2.1%), poor pupil dilatation (4.6%), myopic eye (4.2%), and subluxated lens (0.4%). From this study, lens-related glaucoma and pre-existing diabetic retinopathy were found to be significant risk factors for PCR development during cataract surgery ($p < 0.05$) compared to other risk factors.

Detailed analysis on the stages of PCR during cataract surgery found that more than 50% PCR was noted during segment, nucleus, or epinucleus removal as shown in Figure 1.

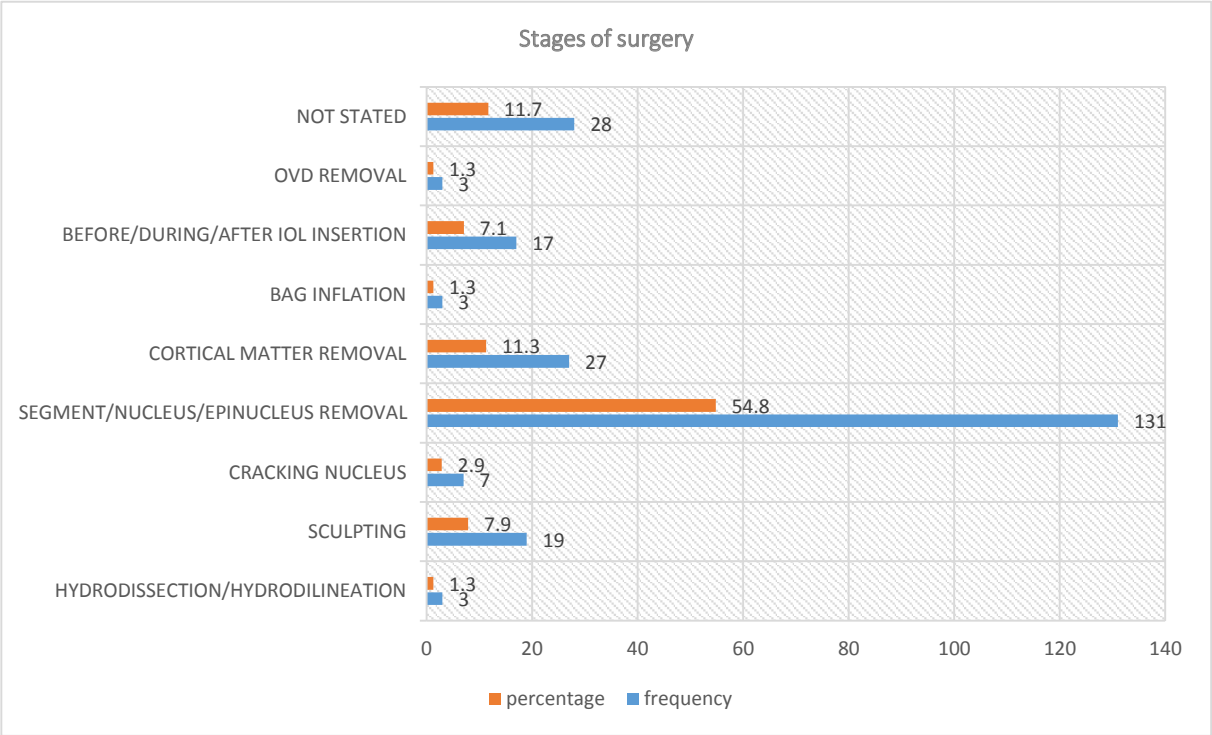

Figure 1 Stages of surgery where PCR was noted

Preoperative and two-month postoperative best corrected visual acuity of 153 eyes with PCR without ocular premorbidity are shown in Figure 2. Twenty (13%) eyes defaulted follow up after two months of cataract surgery and their visual acuity are shown in Figure 3. A Wilcoxon signed rank test indicated that two-month postoperative best corrected visual acuity is better than preoperative best corrected visual acuity (positive ranks = 110, negative rank = 3, ties = 20, $T = 9.003$, $p < 0.0001$).

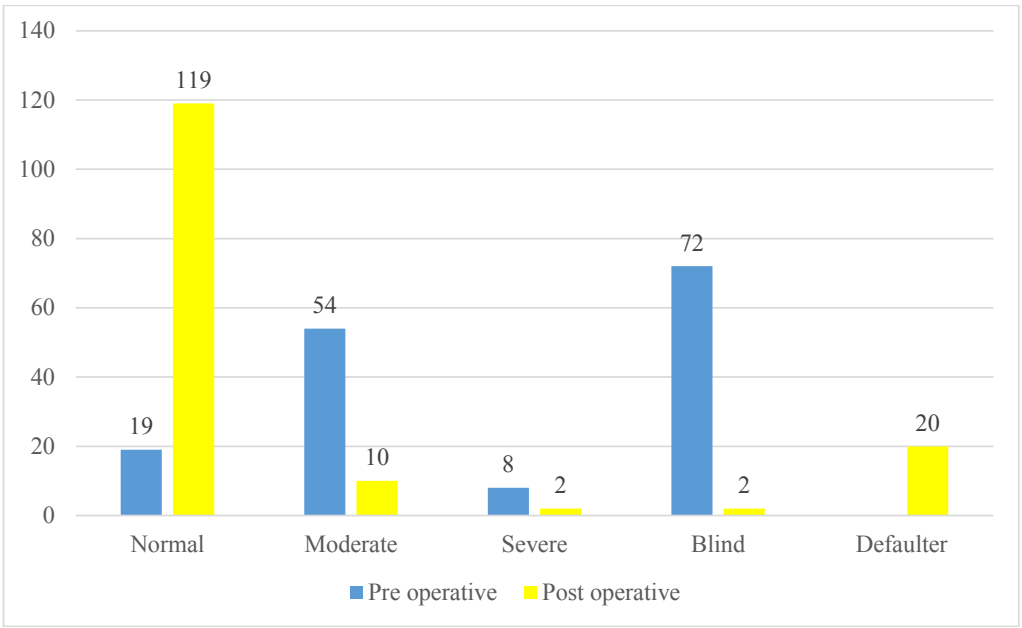

Figure 2 Preoperative and two-month postoperative best corrected visual acuity

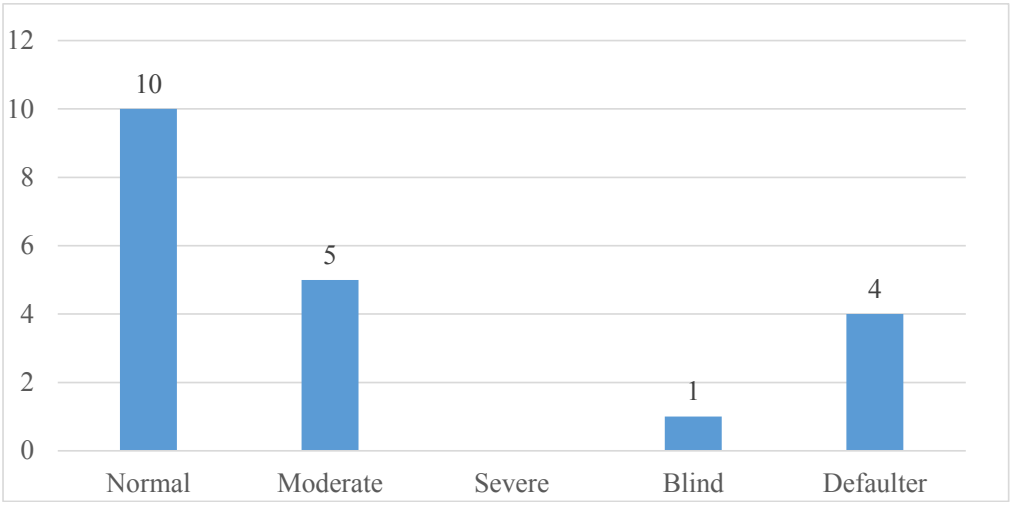

Figure 3 Visual acuity 1-week postoperative (Defaulter 2-month postoperative, *n* = 20)

Further analyses on relationship between two-month postoperative best corrected visual acuity (*n* = 133) and surgeon status, type of surgery, and vitreous loss were done. The results showed no statistically significant relationship between two-month postoperative best corrected visual acuity and surgeon (likelihood ratio *df* = 12, = 17.198, *p* = 0.142). There was also no statistically significant relationship between two-month best corrected visual acuity and vitreous loss (likelihood ratio, *df* = 3, = 4.722, *p* = 0.193). However, two-month postoperative visual acuity showed statistically significant relationship with type of surgery (likelihood ratio, *df* = 6, 14.571, *p* = 0.024).

Two-month best corrected visual acuity (BCVA) on aphakia and IOL implantation (in bag, in sulcus, and in anterior chamber) are presented in Figure 4.

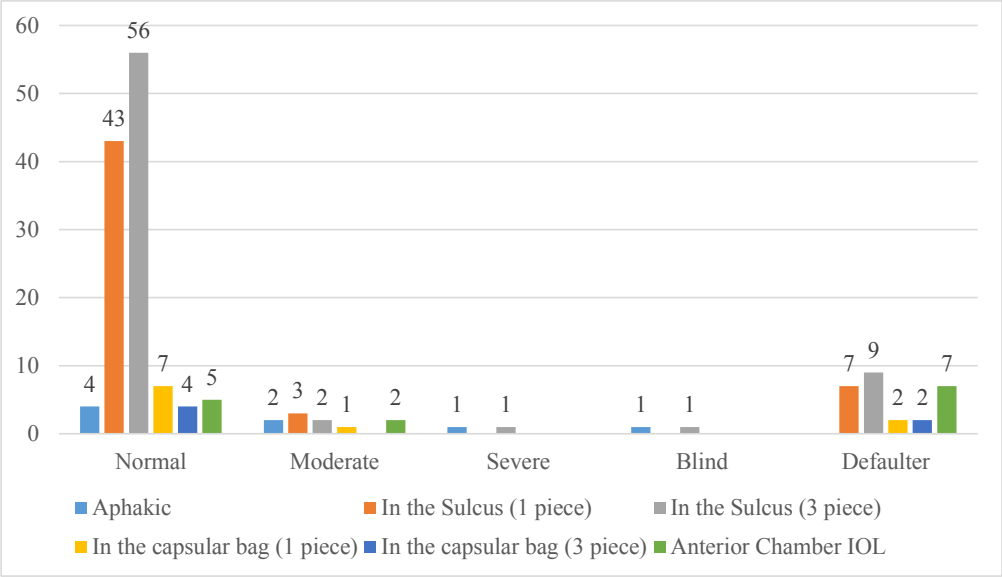

Figure 4 Two-month postoperative BCVA on aphakia and IOL implantation

Subsequent complications that occur as sequelae of PCR are listed in Table 3. There was no corneal decompensation reported.

Factors related to poor visual outcome following PCR in Hospital Melaka are listed in Table 4.

Table 3 Complications that occurred as sequelae of PCR

Complications	Frequency	Percentage
Prolonged inflammation	7	5%
Corneal decompensation	0	–
CMO	3	2%
Secondary increase in IOP	11	7%
Retinal detachment	2	1%

Table 4 Factors causing VA poorer than 6/18 following PCR in Hospital Melaka

Reason	Frequency	Percentage
CMO	2	1.3%
Prolonged inflammation	2	1.3%
High astigmatism	5	3.3%
Anterior corneal opacity	1	0.6%
Retinal detachment	1	0.6%
Lens opacity	1	0.6%
Not stated	2	1.3%

DISCUSSION

As age increases, the risk of PCR increases as well. This is due to increasing nucleus hardness, decreasing pupil width, increasing amount of PXM, and multiple systemic diseases that reduce patients' compliance during surgery[4, 6, 7]. However, in this study, there is no significant difference between age groups (>65 and <65) for risk of getting PCR. This is because in Hospital Melaka, the surgeries for the elderly that are expected to be difficult are performed by experienced senior surgeons.

In Malaysia, males have a higher risk to have PCR during cataract surgery[6]. The reason for increased PCR in male patients is unclear. Males are significantly more likely to take tamsulosin, an alpha receptor blocker used in the treatment of benign prostatic hypertrophy. This can lead to poor pupillary dilation and intraoperative floppy iris syndrome (IFIS). Although this can be effectively managed with intracameral phenylephrine, iris hooks, or Malyugin ring, it remains a risk factor for PCR. Furthermore, males are more likely to be affected by trauma, and traumatic cataract carries an increased risk of PCR. However, in Hospital Melaka, there is no significant difference between genders in the risk to have PCR.

There is no significant difference between the right and the left eye for PCR occurrence[4, 7]. This is compatible with our study. As noted in this study, patients with diabetes mellitus and pre-existing diabetic retinopathy have a significant risk of having PCR. This is consistent with ocular changes in diabetic patients which potentially complicate cataract surgery such as decreased corneal clarity from diabetic keratopathy, impaired pupil dilatation, and thickened lens capsule basement membrane which makes the lens capsule more friable and liable for rupture[4–10].

Only 4% (n = 10) of our patients that had PCR had moderate and high myopia. In addition to weak capsular bag and zonules, axial myopia patients are at increased risk for anterior chamber depth fluctuations and lens–iris diaphragm retropulsion syndrome which is characterized by 360° iridocapsular contact, leading to reverse pupillary block, pupil dilation, and pain. All these conditions increase the risk of having PCR[2 – 4, 11, 12].

The presence of pseudoexfoliation material and having vitrectomy are known risks for PCR occurrence in patients[2 – 4]. But in our centre, both are not statistically significant as

risk factors for PCR because all of the surgeries were done by experienced senior surgeons.

We found that lens-related glaucoma (phacomorphic and phacolytic glaucoma) is statistically significant as a PCR risk factor; this is also compatible with other studies. Phacomorphic glaucoma causes a shallow anterior chamber with high intraocular pressure (IOP). Thus, performing a phacoemulsification in these cases poses multiple challenges. Construction of a clear corneal incision may be difficult owing to iridocorneal apposition in the periphery. Iris-instrument touch may lead to intraoperative miosis, and there is increased iris prolapse owing to a more anterior positioning of the iris. Increased anterior capsular convexity leads to a greater risk of capsular extension, and capsulorhexis is difficult to control. There is increased proximity of the phaco tip and the endothelial cells, thereby leading to increased endothelial cell loss in a cornea that already has less endothelial cell reserve. Injection of viscoelastic substance to deepen the anterior chamber may lead to a further elevation in IOP and increased iris prolapse. The presence of positive vitreous pressure leads to a reduced concavity of the posterior capsule, increasing the risk of posterior capsular rent owing to the proximity of the posterior capsule with the phaco tip[13].

The surgeon's status reflects their experience; thus, this study showed that a less experienced surgeon has higher risk to cause PCR. This is compatible with other studies[4, 5, 7, 9]. The rate of PCR caused by junior surgeons can be reduced by training in a wet lab setting and practicing on cadaver eyes before beginning phacoemulsification on patients. All junior surgeons should be closely supervised by experienced surgeons.

De Silva SR et al. (2014) and Ayesha Amin et al. (2015) reported that patients who underwent ECCE have higher risk to develop PCR, which is compatible with this study[10, 14]. However, Salowi et al. (2017) reported that patients who underwent ECCE have lower PCR rates in Malaysia. In Malaysia, ECCE has lower risk of causing PCR, possibly because of the surgeons' increased familiarity with the ECCE technique as cataract surgeons in Malaysia are taught to master ECCE before they learn phacoemulsification[6].

Even with PCR and vitreous loss, many studies reported good visual outcome after surgery[4, 15–17]. This study also showed that almost 80% of patients without ocular premorbidity had good visual outcome. The remaining 20% of patients without ocular premorbidity had poorer visual outcome due to cystoid macular oedema (CMO), prolonged inflammation, high astigmatism, anterior corneal opacity, retinal detachment, and lens opacity.

CONCLUSION

Most of our patients with PCR had good visual outcome. It is important to identify patients with higher risk factors preoperatively so that necessary precautions can be taken to prevent complications. Surgery for the identified patients should be done by a more experienced surgeon. Gazetting specialists, registrars, and medical officers should receive close supervision by an experienced surgeon throughout the surgery. Early recognition of PCR is important so that it can be successfully managed, eventually resulting in good visual outcome. Cataract surgery, even complicated by PCR, is compatible with good visual outcome if proper management is practised.

CONFLICT OF INTEREST

The authors declare that they have no competing interests in publishing this article.

ACKNOWLEDGMENTS

We would like to thank the Director General of the Ministry of Health Malaysia for his kind permission to publish this article. The authors would also like to acknowledge the contribution of data entry by the Malaysian National Eye Database site coordinators, assigned optometrists, and paramedical staff.

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