

# Safety and effectiveness of an iris hook assisted phacoemulsification in vitrectomized eyes

Ling Bai<sup>1</sup>, Yan-Fen Wang<sup>1</sup>, Farheen Tariq<sup>1</sup>, Yu-Ping Zheng<sup>1</sup>, Hai-Xiao Feng<sup>1</sup>, Feng Wang<sup>1</sup>, Shu Zhang<sup>2,3</sup>

<sup>1</sup>Department of Ophthalmology, the Second Affiliated Hospital of Xi'an Jiaotong University, Xi'an 710004, Shaanxi Province, China

<sup>2</sup>Experimental Teaching Center for Clinical Skills, the Second Affiliated Hospital of Xi'an Jiaotong University, Xi'an 710004, Shaanxi Province, China

<sup>3</sup>Department of Geriatric Medicine, the Second Affiliated Hospital of Xi'an Jiaotong University, Xi'an 710004, Shaanxi Province, China

**Correspondence to:** Feng Wang and Shu Zhang. The Second Affiliated Hospital of Xi'an Jiaotong University, Xi'an 710004, Shaanxi Province, China. wfoculist@126.com; drzhangshu@163.com

Received: 2021-02-26 Accepted: 2021-07-22

## Abstract

• **AIM:** To introduce a simple iris hook assisted phacoemulsification (PE) procedure and evaluate the safety and efficacy of it in completely vitrectomized eyes.

• **METHODS:** A single centre study which included 65 previously completely vitrectomized eyes of 62 patients who underwent cataract surgery. Patients were randomly divided into 3 groups. Patients received PE, and intraocular lens (IOL) implantation with the assistance of iris hook (Synergetics™) as group A (25 eyes); patients who received PE assisted with a 25G pars plana irrigation as group B (20 eyes), and patients who received PE performed without the help of any instrument as group C (20 eyes). Main outcome measures were surgery duration, Ultrasound (U/S) total time, endothelial cell density (ECD), cumulative dissipated energy (CDE) and complications of the procedures.

• **RESULTS:** With the help of iris hook, the patients in group A had the lowest ECD loss rate ( $0.07 \pm 0.03$ ,  $0.09 \pm 0.03$ , and  $0.10 \pm 0.03$ ,  $P < 0.05$ ), shortest CDE ( $12.2 \pm 4.1$ ,  $15.8 \pm 6.0$ , and  $16.0 \pm 6.0$ ,  $P < 0.05$ ) and U/S total time ( $36.6 \pm 13.0$ s,  $46.3 \pm 16.4$ s, and  $47.6 \pm 16.1$ s,  $P < 0.05$ ), and minimal incidence of complications. The longest surgery duration was in group B ( $19.4 \pm 1.6$ min) and maximum complications rate in group C (20% miosis, 10% posterior capsular tears, 5% zonular dialysis, 5% cystoid macular edema). While best-

corrected visual acuity (BCVA), intraocular pressure (IOP) and ECD did not show a significant difference among the three groups.

• **CONCLUSION:** Without prolonged surgery duration, the iris hook assistant method can minimize heat generation during surgery and incidence of complications, which transfer the challenged PE in vitrectomized eyes into a regular surgery. It does not need any change in the hydrodynamic parameters and in the bag PE technique, easy to operate even for junior surgeons.

• **KEYWORDS:** phacoemulsification; vitrectomized eyes; iris hook

**DOI:10.18240/ijo.2021.11.13**

**Citation:** Bai L, Wang YF, Tariq F, Zheng YP, Feng HX, Wang F, Zhang S. Safety and effectiveness of an iris hook assisted phacoemulsification in vitrectomized eyes. *Int J Ophthalmol* 2021;14(11):1735-1740

## INTRODUCTION

With the continuous evolution in vitrectomy techniques and instrumentation, an increasing number of vitreous and retinal diseases are successfully managed with the surgery of pars plana vitrectomy (PPV). But the surgery interferes with the normal intraocular structure and removes the barrier function provided by the vitreous, then lead to increased oxygen exposure to the lens, changes in the lens capsule permeability, and finally promoting the formation of cataract<sup>[1-3]</sup>. The incidence of development of cataract after PPV ranges from 4% to 80 % in various studies, and even up to 100% within a 2-year follow-up observation<sup>[4-7]</sup>. Eventually, most of the patients require cataract surgery.

Because of the normal anatomy is altered, such as the absence of vitreous support and zonular laxity, the cataract surgery in vitrectomized eyes is at high risk for intraoperative and postoperative complications. Although Phacoemulsification (PE) with intraocular lens (IOL) implantation is a relatively safe procedure in vitrectomized eyes, the intraoperative abnormal chamber deepening, unstable posterior capsules, and fluctuation of pupil size are still big challenges for cataract



**Figure 1 Different procedure of phacoemulsification in completely vitrectomized eyes** A: Iris hook was placed at 8 o'clock corneal limbus position (vertically to the main incision); B: A 25G pars plana irrigation was performed at 3.5-mm posterior to the limbus; C: Routine phacoemulsification.

surgeons<sup>[8]</sup>. Currently, the commonly used procedures included using infusion cannula inserted at pars plana during PE or placing the second instrument to lift the iris immediately after lens-iris diaphragm retropulsion syndrome (LIDRS) happened<sup>[8-9]</sup>. The former could provide additional capsular support, but it prolongs the operation time and needs a skilled assistant to control the infusion flow during surgery. The latter one needs proficient surgical skills and has the risk to damage the iris. Furthermore, the literature on the prevention of anterior chamber fluctuation during PE in vitrectomized eyes is sparse.

In this study, we introduce a simple iris hook assisted PE for cataract in vitrectomized eyes, and evaluate its safety and efficacy by comparing its operative parameters and complications with the two popular methods.

#### SUBJECTS AND METHODS

**Ethical Approval** The study was approved by the medical ethics board of the Second Affiliated Hospital of Xi'an Jiaotong University and complied with the Declaration of Helsinki. Informed written consent was obtained from each enrolled patient. The sample size was calculated by G Power 3.1.9.7, assigned effect size of 0.4, an error 0.05, power 0.8. The study was registered at clinicaltrials.gov (NCT03584139).

**Subjects and Examination** This prospective randomized comparative interventional case series study comprised 65 eyes of 62 patients with significant cataract after 23G/25G complete vitrectomy, which needed to undergo cataract surgery. Detailed slit-lamp biomicroscopy and dilated fundus ophthalmoscopy examination were performed. The IOL power was calculated using the IOL Master 500 in 56 eyes and A-Scan in 9 eyes with the SRK/T formula. The objective degree of nucleus density was obtained from 1 to 5 using pentacam nucleus densitometry (PND) software in Pentacam Scheimpflug imaging system (Oculus, Wetzlar, Germany).

Patients were divided into 3 groups randomly. In group A, patients received PE and IOL implantation with the assistance of an iris hook (Synergetics<sup>TM</sup>). In group B, PE was assisted with a 25G pars plana irrigation. In group C, PE performed without the help of any instrument.

The details of surgery duration, Ultrasound (U/S) total time, cumulative dissipated energy (CDE), and the incidence of

**Table 1 Phacoemulsification hydrodynamic parameters**

Set	Parameters	PE	I/A
I	BHt (cm)	90	75
	Vac (mm Hg)	400	450
	Aps (mm Hg)	38	40
II	BHt (cm)	65	60
	Vac (mm Hg)	300	350
	Aps (mm Hg)	30	35

PE: Phacoemulsification; I/A: Irrigation and aspiration of residual cortex; BHt: Bottle height; Vac: Vacuum pressure; Asp: Aspiration pressure.

any complication (LIDRS, iris damage, miosis, posterior capsular tears, zonular dialysis, and postoperative cystoid macular edema) were recorded. All patients were reviewed at a postoperative interval of 4wk. The outcome measures were preoperative and postoperative best-corrected visual acuity (BCVA), intraocular pressure (IOP) and endothelial cell density (ECD).

**Surgical Technique** The surgical procedures (Figure 1) were performed by the same surgeon (Bai L). The type of anesthesia was sub-Tenon with lidocaine. For group A, an iris hook was placed at 8 o'clock corneal limbus position (vertically to the main incision) to lift the iris at the beginning of the surgery, then started routine PE as following. A 3.0-mm clear corneal incision at 11 o'clock was made, then 5.5-mm continuous curvilinear capsulorhexis and hydrodissection was achieved. The PE was performed with a technique of "stop-chop" (Ozil IP, Infiniti, Alcon). Finally, a yellow-coloured UV-filter hydrophobic IOL (HOYA PY-60R) was implanted in the capsular bag. The intraoperative hydrodynamic parameters were set I in Table 1. For group B, a 25G pars plana irrigation was performed at 3.5-mm posterior to the limbus at the beginning of the surgery, then started routine PE. The hydrodynamic parameters started from set I in Table 1. The assistant adjusted the pars plana irrigation on/off and hydrodynamic parameters according to the local situation during surgery. For group C, routine PE was performed without the assistance of any instrument. The hydrodynamic parameters started from set I in Table 1, when excessively anterior chamber deepening, pupil dilatation and patient pain occurred, the parameters

**Table 2 Basic characteristics for 65 eyes in this study**

Characteristics	Group A	Group B	Group C
Eyes ( <i>n</i> )	25	20	20
Age (y)	56.8±13.2	59.4±12.7	59.0±11.0
Male ( <i>n</i> )	13	11	10
Vitrectomy indication			
Proliferated diabetic retinopathy	12	11	12
Central retinal vein occlusion	5	2	3
Retinal detachment	5	3	2
Vitreous hemorrhage	3	4	3
PPV times	1.2±0.4	1.1±0.3	1.1±0.3
Intravitreal tamponade			
Balanced salt solution	14	11	11
Air	5	4	4
C <sub>3</sub> F <sub>8</sub>	3	3	3
Silicon oil <sup>a</sup>	3	2	2
Interval between PPV and cataract surgery (mo)	23.0±7.8	20.8±6.8	21.4±7.6
Axial length (mm)	24.34±3.45	23.98±4.67	24.67±4.05
Pentacam nucleus densitometry (1-5)	2.8±1.1	2.5±1.1	2.7±1.0

PPV: Pars plana vitrectomy. <sup>a</sup>If the patient included in this study, the silicon oil removal was already performed at least 3mo before phacoemulsification.

change to set II in Table 1. If still irreversible, the chopper was used to lift the iris margins immediately as recommended<sup>[9-10]</sup>. After surgery, topical Tobradex<sup>®</sup> (tobramycin and dexamethasone ophthalmic suspension) and pranopfen (non-steroidal anti-inflammatory drugs, NSAIDs) eye drops were administered 4 times a day in the first two weeks, followed by topical NSAIDs over 6wk.

**Statistical Analysis** SPSS version 23 (SPSS Inc., Chicago, IL, USA) statistical software was utilized to analyze the data. BCVA was converted to a logarithm of the minimum angle of resolution (logMAR) equivalent for analysis. The data were compared using ANOVA or Fisher's exact test among the three groups. A *P* value of <0.05 was considered statistically significant. Bonferroni adjust required *P*<0.0167 as significant.

## RESULTS

The patient demographics, indication for PPV, type of intravitreal tamponade, the interval between PPV and PE were all noted at the beginning (Table 2). There was no significant difference among the three groups in sex, indication for PPV, PPV times, interval between PPV and cataract surgery, axial length (AL), and PND (Table 2).

The mean preoperative BCVA was improved, and the mean ECD decreased significantly at 4wk after surgery in all three groups (*P*<0.05). We did not observe any significant difference in BCVA, IOP, and ECD among the groups (*P*>0.05). While the ECD loss rate in group A was significantly lower than the other two groups (*P*<0.05; Table 3).

The surgery duration of group B was much longer than other groups (*P*<0.05). Although there was no significant difference between group A and C (*P*>0.05), the duration of group A was still the shortest (Table 3). The CDE and U/S total time was estimated of total PE energy. The less of them, the less heat generation and damage during surgery. The CDE and U/S total time difference among them were significant (*P*<0.05). The minimal CDE and U/S total time were in group A, which were much less than group B and group C (*P*<0.05; Table 3).

The complications included LIDRS, iris damage, miosis, posterior capsular tears, zonular dialysis, and cystoid macular edema. LIDRS happened in 11 eyes (55%) of group C, 3 eyes (15%) in group B, while none in group A (*P*=0.00). Paired comparative analysis after Bonferroni adjust showed LIDRS happened much less in group A than group C (*P*<0.0167). To reverse LIDRS, a chopper was used to lift the edge of the iris, and thus damaged iris in 3 eyes (15%) of group C. None happened in group A and group B. Miosis happened in 2 eyes (8%) in group A, 3 eyes (15%) in group B, and 4 eyes (20%) in group C. Posterior capsular tears occurred in 2 eyes (10%), zonular dialysis in 1 eye (5%), cystoid macular edema in 1 eye (5%) in group C, and none in group A and B (all *P*>0.05; Table 4).

## DISCUSSION

The patients involved in this study were undergone complete vitrectomy and severe cataract. Complete was emphasized because these eyes have entirely lost vitreous support and zonular laxation. There will be more incidence of

**Table 3 Perioperative characteristics of each procedure**

Characteristics	Group A	Group B	Group C	F	P
BCVA (logMAR)					
Preoperative	0.84±0.27	0.81±0.27	0.83±0.30	0.08	0.927
Postoperative	0.32±0.20	0.33±0.16	0.33±0.19	0.007	0.993
IOP (mm Hg)					
Preoperative	14.7±2.2	14.2±2.1	14.3±1.9	0.3	0.741
Postoperative	14.0±1.5	14.2±1.5	14.1±1.7	0.06	0.945
ECD (cells/mm <sup>2</sup> )					
Preoperative	2508±264	2558±234	2599±227	0.8	0.463
Postoperative	2344±257	2326±224	2331±219	0.04	0.964
ECD loss rate	0.07±0.03	0.09±0.03	0.10±0.03	8.9	0.000 <sup>a</sup>
Surgery duration (min)	15.0±1.5	19.4±1.6	16.0±2.0	38	0.000 <sup>a</sup>
U/S total time (s)	36.6±13.0	46.3±16.4	47.6±16.1	3.6	0.033 <sup>a</sup>
CDE	12.2±4.1	15.8±6.0	16.0±6.0	3.6	0.034 <sup>a</sup>

BCVA: Best-corrected visual acuity; IOP: Intraocular pressure; ECD: Endothelial cell density; U/S total time: Ultrasound total time; CDE: Cumulative dissipated energy. <sup>a</sup>The significant difference among three groups.

**Table 4 Complications of each procedure**

Complications	Group A	Group B	Group C	P	n (%)
LIDRS	0	3 (15)	11 (55)	0.00 <sup>a</sup>	
Iris damage	0	0	3 (15)	0.052	
Miosis	2 (8)	3 (15)	4 (20)	0.5	
Posterior capsular rupture	0	0	2 (10)	0.18	
Zonular dialysis	0	0	1 (5)	0.6	
Cystoid macular edema	0	0	1 (5)	0.6	

LIDRS: Lens-iris diaphragm retropulsion syndrome. <sup>a</sup>The significant difference among three groups.

complications during PE. In group C, the anterior chamber was much deeper than other groups for the absence of additional vitreous support and zonular laxation. The handpiece of PE needed to be inserted deeply and perpendicular during any procedure, which limited manipulation feasibility and increased nucleus chopping difficulty. This could explain the maximum U/S total time and CDE among the three groups. Two lenses were divided with chopping technique out of the bag at the anterior chamber, which may increase the endothelial cell injury, and the technique is not easy to operate. In group B, we inserted an infusion cannula at pars plana to aid in maintaining IOP stability and provide additional capsular support during PE in vitrectomized eyes. But this procedure needs a second bottle of infusion and prolong the surgery duration, which is significantly longer than other groups. Two eyes needed to suture the sclera infusion incision at the end. It is noteworthy that a skilled assistant is required for this procedure to control the on/off of infusion valve during surgery according to the anterior chamber fluctuation, which is not easy for a junior surgeon. In group A, an iris hook was used to lift the iris at the beginning of the surgery. A gap will be formed between the iris and lens capsule. Once the irrigation starts, the

pressure between the anterior and posterior chambers could equalize automatically. Vishwanath<sup>[11]</sup> first tried this method in a small group of patients, without further systematical and comparative observation. In this study, we found it was easy to maintain the anterior chamber stable in vitrectomized eyes by using an iris hook during PE. The surgery duration was 15.0±1.5min, significantly less than group B, while the U/S total time and CDE were significantly less than group B and C, which minimized heat generation and damage to the eye. Mean ECD loss after PE in various studies ranges from 6% to 12%<sup>[12-13]</sup>, similar to that in our study. Although there was no difference in the absolute value of perioperative ECD between the groups, the ECD loss rate is significantly lower in group A, which could be explained by the least CDE and U/S total time use.

LIDRS is characterized by anterior chamber deepening, retropulsion of the iris, and pupil dilation during PE. Patients have discomfort and pain under topical anesthesia suddenly, and an excessively deep anterior chamber renders PE more difficult. Post-vitrectomized eyes, especially with extensive or multiple vitrectomy is its risk factors<sup>[14]</sup>, because loosen zonular and an infusion pushed 360-degree iridocapsular

contact is its predominant cause<sup>[15-16]</sup>. If it can't be reversed, a sudden collapse of the anterior chamber and pupillary miosis (infusion deviation syndrome) may happen. In group C, we observed LIDRS occurred in 55% of patients, it is consistent with the study of Ghosh *et al*<sup>[9]</sup> (53%). We first lowered fluidic parameters (from set I to set II). If it's still irreversible, a chopper immediately used to lift the edge of the iris to equalize the pressure between the anterior chamber and the posterior chamber, as described by Cheung and Hero<sup>[15]</sup>. We need to repeat this operation each time when the eye is entered infusion, and thus 3 eyes (15%) had iris injury during the procedure. One eye with iris injury finally occurred macular edema 4wk after surgery. While no LIDRS, resulting from the gap for preventing 360-degree iridocapsular contact, happened in Group A. Without lifting the iris by rigid chopper, iris damage also didn't happen. Slight miosis occurred in 2 eyes during surgery, but the pupil still semi dilated. After adrenaline anterior chamber administration, we got dilated pupil and completed the surgery.

Posterior capsular rupture (PCR) is the most common complication during PE in vitrectomized eyes<sup>[4]</sup>. Lee *et al*<sup>[17]</sup> reported about 11.4% and attributed it to unstable anterior chamber depth, flaccid and mobile posterior capsule in vitrectomized eyes. In consistent with the references, PCR occurred in 2 eyes (10%) in group C. Because of the extra infusion in the vitreous cavity and consequently stabilized posterior capsule, no PCR occurred in group A and group B. Zonular dialysis also didn't occur in these two groups due to the stable anterior chamber depth and no more damage to zonular.

Although the incidence of iris damage, miosis, PCR, zonular dialysis, and cystoid macular edema did not show any significant difference among three groups, we think it may be significance with a larger sample size for the obvious feasibility and safety in group A. Furthermore, PE hydrodynamic parameters in group A are the same as in non-vitrectomized eyes (set I). The stop-chop technique in the capsular bag was performed easily for all the patients in this group.

Postoperative BCVA are all improved in three groups at 4wk follow-up, without any significant difference between the groups. However, we still emphasize that the outcomes depend on the retina status and preexisting posterior segment pathology, not the technique. Another trifle thing we want to mention is that vitrectomized eyes may experience pain and discomfort due to the iris fluctuation and LIDRS. We suggest sub-Tenon anesthesia to make patients more comfortable during surgery. The IOL used in this study is a yellow-colored blue light-filter IOL (HOYA PY-60R), which is designed to reduce the absorption of ultraviolet (UV) and short-wavelength visible light. It can be used in vitrectomized eyes and possibly

providing macular protection<sup>[8,18-19]</sup>.

In conclusion, PE in vitrectomized eyes is a challenging situation. With the assistance of an iris hook, we can achieve a stable anterior chamber and minimize the incidence of complications. There is also no need to change the hydrodynamic parameters and PE in the bag technique, easy to operate even for junior surgeons.

#### ACKNOWLEDGEMENTS

**Foundation:** Supported by the Research and Development Program of Shaanxi Province (No.2021SF-161).

**Conflicts of Interest:** Bai L, None; Wang YF, None; Tariq F, None; Zheng YP, None; Feng HX, None; Wang F, None; Zhang S, None.

#### REFERENCES

- 1 Wong IY, Wong D. Special adjuncts to treatment. *Retina*. Amsterdam: Elsevier, 2013:1735-1783.
- 2 Rey A, Jürgens I, Maseras X, Dyrda A, Pera P, Morilla A. Visual outcome and complications of cataract extraction after pars plana vitrectomy. *Clin Ophthalmol* 2018;12:989-994.
- 3 Holekamp NM, Shui YB, Beebe DC. Vitrectomy surgery increases oxygen exposure to the lens: a possible mechanism for nuclear cataract formation. *Am J Ophthalmol* 2005;139(2):302-310.
- 4 Yau GL, Silva PS, Arrigg PG, Sun JK. Postoperative complications of pars plana vitrectomy for diabetic retinal disease. *Semin Ophthalmol* 2018;33(1):126-133.
- 5 Helbig H, Kellner U, Bornfeld N, Foerster MH. Cataract surgery and YAG-laser capsulotomy following vitrectomy for diabetic retinopathy. *Ger J Ophthalmol* 1996;5(6):408-414.
- 6 Kataria AS, Thompson JT. Cataract formation and progression in patients less than 50 years of age after vitrectomy. *Ophthalmol Retina* 2017;1(2):149-153.
- 7 Schreur V, Brouwers J, Van Huet RAC, Smeets S, Phan M, Hoyng CB, de Jong EK, Klevering BJ. Long-term outcomes of vitrectomy for proliferative diabetic retinopathy. *Acta Ophthalmol* 2021;99(1):83-89.
- 8 Kim WS, Kim KH. Cataract surgery in vitrectomized eyes. *Challenges in Cataract Surgery*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2016:97-105.
- 9 Ghosh S, Best K, Steel DH. Lens-iris diaphragm retropulsion syndrome during phacoemulsification in vitrectomized eyes. *J Cataract Refract Surg* 2013;39(12):1852-1858.
- 10 Packard RB. Avoiding lens-iris diaphragm retropulsion syndrome. *J Cataract Refract Surg* 2010;36(7):1245.
- 11 Vishwanath MR. Lens-iris diaphragm retropulsion syndrome and iris hooks. *J Cataract Refract Surg* 2006;32(5):708.
- 12 Pereira AC, Porfirio F Jr, Freitas LL, Belfort R Jr. Ultrasound energy and endothelial cell loss with stop-and-chop and nuclear preslice phacoemulsification. *J Cataract Refract Surg* 2006;32(10):1661-1666.
- 13 Walkow T, Anders N, Klebe S. Endothelial cell loss after phacoemulsification: relation to preoperative and intraoperative parameters. *J Cataract Refract Surg* 2000;26(5):727-732.

- 14 Lim DH, Shin DH, Han G, Chung ES, Chung TY. The incidence and risk factors of lens-iris diaphragm retropulsion syndrome during phacoemulsification. *Korean J Ophthalmol* 2017;31(4):313-319.
- 15 Cheung CM, Hero M. Stabilization of anterior chamber depth during phacoemulsification cataract surgery in vitrectomized eyes. *J Cataract Refract Surg* 2005;31(11):2055-2057.
- 16 Cionni RJ, Barros MG, Osher RH. Management of lens-iris diaphragm retropulsion syndrome during phacoemulsification. *J Cataract Refract Surg* 2004;30(5):953-956.
- 17 Lee JY, Kim KH, Shin KH, Han DH, Lee DY, Nam DH. Comparison of intraoperative complications of phacoemulsification between sequential and combined procedures of pars plana vitrectomy and cataract surgery. *Retina* 2012;32(10):2026-2033.
- 18 Falkner-Radler CI, Benesch T, Binder S. Blue light-filter intraocular lenses in vitrectomy combined with cataract surgery: results of a randomized controlled clinical trial. *Am J Ophthalmol* 2008;145(3):499-503.
- 19 Downie LE, Busija L, Keller PR. Blue-light filtering intraocular lenses (IOLs) for protecting macular health. *Cochrane Database Syst Rev* 2018;5(5):CD011977.