·Clinical Research·

Rotational stability of plate haptic toric intraocular lenses after combined 25-gauge vitrectomy and cataract surgery

Lara Buhl, Julian Langer, Stefan Kassumeh, Thomas C. Kreutzer, Wolfgang J. Mayer, Siegfried G. Priglinger

Department of Ophthalmology, University Hospital, LMU Munich, Munich 80336, Germany

Correspondence to: Siegfried G. Priglinger. Department of Ophthalmology, University Hospital, LMU Munich, Mathildenstraße 8, Munich 80336, Germany. siegfried.priglinger@med.uni-muenchen.de

Received: 2022-10-03 Accepted: 2023-06-21

Abstract

● **AIM:** To evaluate the postoperative intraocular lens (IOL) rotational stability and residual refractive astigmatism following combined 25-gauge vitrectomy and cataract surgery with implantation of a plate haptic toric IOL.

● **METHODS:** In this retrospective case series, 32 eyes of 32 patients underwent a combined 25-gauge vitrectomy and phacoemulsification for vitreoretinal diseases and cataract with regular corneal astigmatism of at least 1 diopter (D). A plate haptic toric IOL (AT Torbi 709M, Carl Zeiss Meditec AG) was implanted in all eyes. The outcome measures were rotational stability and refractive astigmatism up to 6mo postoperatively as well as the best corrected visual acuity (BCVA).

● **RESULTS:** Preoperative refractive astigmatism was 2.14±1.17 D, which was significantly reduced to 0.77±0.37 D six to eight weeks postoperatively and remained stable throughout the observation period (0.67±0.44 D at three months and 0.75±0.25 D at six months; for all groups: P<0.0001 compared to baseline). BCVA improved significantly from 0.36±0.33 logMAR preoperatively to 0.10±0.15 logMAR following surgery (P=0.02). Mean IOL axis deviation from the target axis was 3.4°±2.9° after six to eight weeks and significantly decreased over time (2.4°±2.6° six months after surgery; P=0.04). In one patient IOL, re-alignment was performed.

● **CONCLUSION:** Corneal astigmatism is significantly reduced following combined 25-gauge vitrectomy and cataract surgery. The plate haptic toric IOL position and axis remain stable during the observation period of six months.

● **KEYWORDS:** combined phaco-vitrectomy; toric intraocular lens; rotational stability; corneal astigmatism; cataract; vitreoretinal disease

DOI:10.18240/ijo.2023.08.07

Citation: Buhl L, Langer J, Kassumeh S, Kreutzer TC, Mayer WJ, Priglinger SG. Rotational stability of plate haptic toric intraocular lenses after combined 25-gauge vitrectomy and cataract surgery. *Int J Ophthalmol* 2023;16(8):1231-1236

INTRODUCTION

Combined phaco-vitrectomy has become increasingly popular to treat both cataract and vitreoretinal pathologies[1]. In contrast to sole pars plana vitrectomy with possible induction of lens opacity, the combined procedure provides long-lasting visual recovery with no further intervention needed[2]. From a surgeon's point of view, combined phaco-vitrectomy improves intraoperative visualization of the retina due to the lower pseudophakic lens thickness and superior lens transparency. Previous studies proved that combined phaco-vitrectomy's functional and anatomical outcome is comparable to a sequential approach[2-3]. To achieve optimal postoperative visual quality, the implantation of a toric intraocular lens (IOL) is appropriate in patients with preoperative regular corneal astigmatism of ≥1.0 diopters (D). However, in combined phaco-vitrectomy, numerous obstacles, namely a possible myopic shift, a surgically induced astigmatism, possibly altering the anticipated refractive outcome, and toric IOL axis alignment need to be considered[4]. In particular, the rotational stability and position of the IOL following the removal of the vitreous body and the temporary endotamponade of the vitreous cavity can be of concern[5]. Notably, previous vitrectomy is associated with a more severe postoperative IOL tilt after phacoemulsification[6].

Recent studies investigated the rotational stability of loop haptic IOL in combined phaco-vitrectomy to be comparable to phacoemulsification alone[7-9]. However, to our knowledge, toric IOLs with other haptic designs have not yet been evaluated after phaco-vitrectomy. To this end, this retrospective case series focuses on the postoperative rotational stability of a plate haptic toric IOL and the postoperative residual refractive astigmatism following combined 25-gauge vitrectomy and phacoemulsification.

SUBJECTS AND METHODS

Ethical Approval Before data collection and analysis, approval was obtained by the local institutional review board of Ludwig Maximilian University (approval No.22-0591). This study complies with the criteria defined in the Declaration of Helsinki. Written informed consent was collected from all patients.

Study Design Totally 32 eyes of 32 patients were included in this retrospective case series conducted at the Department of Ophthalmology, University Hospital, LMU Munich, Munich, Germany. All included patients met the following criteria: They presented with an age-related cataract, regular corneal astigmatism ≥1.0 D, and a vitreoretinal disease requiring vitrectomy. Medical indications for vitrectomy were rhegmatogenous retinal detachment, epiretinal membrane, full-thickness macular hole, or vitreous haze/hemorrhage. Eyes for which follow-up data were not available were excluded from the study. The regular corneal astigmatism of more than 1.0 D was preoperatively assessed by topographic Scheimpflug analysis (Pentacam®, Oculus Optikgeräte GmbH, Wetzlar, Germany). Optical biometry measurements and IOL power calculations were performed using the IOLMaster 700 (Carl Zeiss Meditec AG, Jena, Germany). In two eyes, the axial length was determined by immersion ultrasound biometry, as optical biometry was not possible due to vitreous hemorrhage. Conventional phacoemulsification followed by toric IOL implantation (AT Torbi 709 M, Carl Zeiss Meditec AG, Jena, Germany) and 25-gauge pars plana vitrectomy were carried out by an experienced cataract and vitreoretinal surgeon (Priglinger SG or Kreutzer TC). Cataract surgery was performed using a 2.5 mm clear corneal incision on the steep astigmatism axis and a curvilinear capsulorhexis between 4.5 to 5.5 mm. Following phacoemulsification, irrigation-aspiration was done for complete lens cortex removal. After IOL insertion, the CALLISTO eye and Z ALIGN digital tracking system (Carl Zeiss Meditec, Jena, Germany) was used for intraoperative axis alignment. Pars plana vitrectomy was performed according to the underlying retinal disease consisting of a core vitrectomy followed by vitreous removal in the periphery with globe indentation. For endotamponade, either air, gas (C_2F_6 or SF_6 gas tamponade), or 1000 centistoke silicone oil was used. The sclerotomies were closed using sutures.

Outcome Measures The primary goal was to evaluate the IOL rotational stability and the residual refractive astigmatism postoperatively. Therefore, preoperatively as well as six weeks, three months, and six months postoperatively, a slit lamp examination with the determination of the current IOL axis, fundoscopy, and assessment of the best corrected visual acuity (BCVA) according to DIN 58220 [German Institute for Standardization (DIN) 58220] were performed.

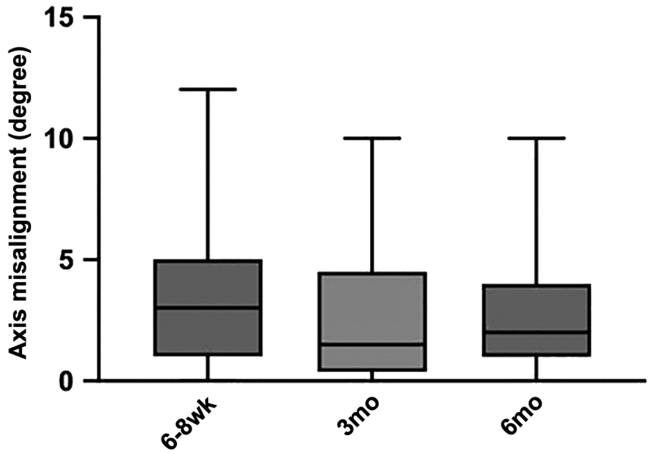

Figure 1 Axis misalignment of plate haptic intraocular lens after combined phaco-vitrectomy.

Statistical Analysis Statistical analysis was performed using Prism 8 (GraphPad Software, San Diego, CA, USA). A $P<0.05$ was considered statistically significant. Statistical intergroup differences were analyzed using mixed-effects analysis followed by Tukey's multiple comparison test. To compare the mean of two groups, a non-parametric Mann-Whitney test was performed. A Pearson's correlation coefficient was calculated to correlate the degree of misalignment and axial length.

RESULTS

Totally 32 eyes of 32 consecutive patients, who underwent a combined phaco-vitrectomy with the implantation of a plate haptic toric IOL, were included. At the time of surgery, the mean age of the patients was 64.7±8.3y. Sixteen eyes received a gas endotamponade following vitrectomy due to retinal detachment, whereas 15 eyes had air endotamponade after vitrectomy with epiretinal membrane peeling. One eye received silicone oil endotamponade. Table 1 displays detailed preoperative baseline patient characteristics.

Visual Acuity The preoperative BCVA of 0.36±0.33 logMAR significantly improved to 0.19±0.13 logMAR (P=0.05) six to eight weeks postoperatively and remained stable during the observation time (0.15±0.15 logMAR after three months, P=0.06; 0.10±0.15 logMAR after six months, P=0.02 compared to baseline).

Intraocular Lens Rotational Stability The mean IOL axis rotation was 3.4°±2.9° six to eight weeks after combined phaco-vitrectomy. Further, axis misalignment was 2.7°±3.2° three months and 2.4°±2.6° six months following surgery; P=0.4 and P=0.04, respectively (Figure 1). In one eye, the toric IOL was re-rotated. In our cohort, toric IOL rotation did not significantly correlate with the axial length (Pearson's

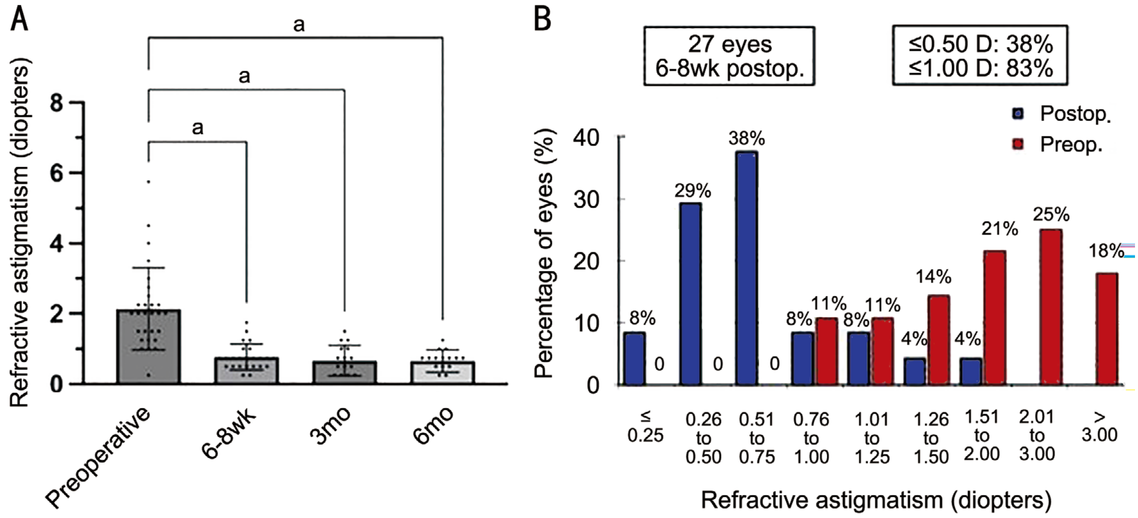

Figure 2 Change in refractive astigmatism after combined phaco-vitrectomy with plate haptic toric intraocular lens (IOL) implantation (A, B) [a]*P*<0.0001.

Table 1 Preoperative baseline patient characteristics

Items	Data
Patients (*n*)	32
Eyes (*n*)	32
Sex (female: male; *n*)	11:21 (34% female)
Mean age (y)	64.7±8.3
Indication for vitrectomy, *n* (%)	
Retinal detachment	16 (50)
Epiretinal membrane	12 (37.5)
Vitreous hemorrhage	2 (6.25)
Full-thickness macular hole	2 (6.25)
Mean best corrected visual acuity (logMAR)	0.36±0.33
Axial length (mm)	24.79±1.46
Refractive corneal cylinder (D)	2.14±1.17

r=-0.04, *P*=0.80). Furthermore, no significant difference in toric IOL rotation was observed for combined phaco-vitrectomy comparing air or gas tamponade (3.2°±3.4° and 2.3°±1.7°, *P*=0.64). In one case, a silicone oil tamponade was used, which was removed three months after the initial surgery. No axial shift was found in this patient postoperatively.

Postoperative Refraction The mean absolute preoperative refractive astigmatism was 2.14±1.17 D, which was significantly reduced to 0.77±0.37 D six to eight weeks after phaco-vitrectomy (*P*<0.0001) and remained stable (0.67±0.44 D at three months and 0.75±0.25 D at six months; *P*<0.0001 compared to baseline; Figure 2A). After six to eight weeks, the refractive astigmatism was within 1 D in 14 eyes (83%) and within 0.5 D in 9 eyes (38%; Figure 2B). The predictive refractive error was 0.38±0.8 D six to eight weeks after surgery and maintained steadily throughout the observation period (0.42±0.78 D at three months and 0.35±0.8 D at six months; *P*=0.9 and *P*=0.9, respectively).

DISCUSSION

In the present case series, we observed rotational stability of a plate haptic toric IOL implanted during combined 25-gauge vitrectomy and phacoemulsification. Preoperative refractive corneal astigmatism was significantly reduced upon toric IOL implantation and remained steady over the observation time, whereas the BCVA acuity significantly increased.

Stable intracapsular positioning of the toric IOL is crucial for long-term astigmatism reduction and patient satisfaction. However, the biomechanical stability of the IOL is highly dependent on its material properties, haptic design, and the intraocular forces acting upon it[10-11]. Particularly in combined phaco-vitrectomy, IOL displacements appear more likely due to the loss of vitreous support and the endotamponade being used[12]. Especially the early phase after toric IOL implantation is prone to positional instability until the lens capsule firmly adheres to the implanted IOL[10]. Among the IOL materials used, hydrophobic implants exert the strongest adhesive properties, thus decreasing the likelihood of early postoperative rotational instability and enhanced posterior capsule opacification[13]. In the present study, we utilized a plate haptic toric IOL consisting of hydrophilic acrylic with hydrophobic surface properties[14]. Previous studies on the rotational stability of this specific toric IOL reported a mean axial misalignment of 1.8°-4.4° following three and six months after sole cataract surgery, which is comparable to prior studies using loop haptic IOLs[15-20]. This is in line with our results for combined phaco-vitrectomy. Rotational stability of the plate haptic IOL was observed over the 6-month observation period with a maximum mean axis misalignment of 3.4°±2.9° six to eight weeks postoperatively.

To our knowledge, the feasibility of plate haptic toric IOL implantation in combined phaco-vitrectomy has not yet been evaluated. Previous studies on the rotational stability of toric IOL during combined phaco-vitrectomy utilized a one-piece loop haptic IOL composed of hydrophobic acrylic polymer[7-9,21-22]. The mean postoperative axis deviation in these studies was 3.3°-5.7° within three months to two years postoperatively[7-9,21-22]. In the present study, we found a similar mean postoperative axis misalignment after combined phaco-vitrectomy, indicating that the rotational stability after phacovitrectomy is comparable to those of loop haptic IOLs in combined phaco-vitrectomy[7-9,21-22].

Rotational instability can result from a mismatch of the capsule size and the size of the IOL used. A problem that is more likely to occur in patients with high myopia[16,23-24]. In our study, however, no significant correlation between the axial length and the postoperative rotational instability was observed, although 60% of all eyes included were considered to have high or moderate myopia (axial length >24.5 mm). This is particularly interesting as the toric IOL used in our investigation is of average size with a diameter of 11 mm[14]. However, large-scale studies are needed to assess the impact of axis length on postoperative rotational instability in phaco-vitrectomy, especially in relation to parameters such as endotamponade and the IOL type used. For instance, a previous study demonstrated a positive relationship between axial length and rotational stability, yet the high variability suggests other influencing factors[24].

Not only the loss of vitreous support but also the type of endotamponade used has been previously described to significantly impact the effective lens position and IOL tilt after phaco-vitrectomy[25-26]. A gas endotamponade is considered to induce a myopic shift by pushing the IOL forward, an effect that appears to persist after gas resolution[25,27]. Similarly, vitrectomy with air endotamponade was associated with an increased postoperative IOL tilt and decentration compared to phacoemulsification alone[28]. However, a possible axial displacement of a (toric) IOL depending on the type of endotamponade used, has not been further evaluated. In our study, eyes receiving air tamponade showed a slightly greater axis misalignment tendency than those receiving gas tamponade after phaco-vitrectomy. We assume that due to the relatively fast resolution of the air tamponade, the fixation of the IOL by capsular fibrosis is still incomplete and can thus lead to consecutive (backward) movement and temporary loosening of the IOL. Subsequently, potential intracapsular rotation may occur. Similarly, a higher degree of axial rotation seemed to be more evident in the early postoperative phase. However, these findings need to be validated in further studies with more patients included.

Phaco-vitrectomy can be associated with an increased predictive refractive error related not solely to intraocular IOL displacement, but to inaccurate axial length measurements and a change in refractive index due to the removal of the vitreous[29]. Thus, underlying retinal pathologies, such as retinal detachment and increased macular thickness, and corneal indentation during ultrasound biometry may falsely result in shorter axis length measurements, causing a postoperative myopic shift[30-31]. We observed no myopic shift following phaco-vitrectomy. However, the small sample size and heterogeneity of our cohort may impede our results.

Our retrospective case series had several limitations. Above all, the limited sample size indeed complicated further subgroup analysis. The COVID-19 pandemic also resulted in an increased loss of follow-up after some patients declined additional post-operative assessment at our tertiary referral hospital due to the risk of infection. Moreover, postoperative axis alignment was evaluated solely using slit lamp examination with high inter-observer variability. Because we determined the rotational stability of the plate toric IOL not until six to eight weeks postoperatively after the endotamponade was already resorbed, we cannot conclude the direct effects of the gas or air endotamponade.

We show the rotational stability of a plate haptic toric IOL implanted during combined phaco-vitrectomy comparable to loop haptic IOLs. Further, the rotational stability is in line with the results of sole plate haptic toric IOL implantation during cataract surgery. In addition, our data suggest that an axis misalignment is more likely to occur within the early postoperative phase.

ACKNOWLEDGEMENTS

The authors would like to thank all employees of the private outpatient clinic for their support.

Authors' contributions: Buhl L, Langer J, and Kassumeh S: Data acquisition and analysis. Priglinger SG and Mayer WJ: Study design. Priglinger SG and Kreutzer TC performed all phacovitrectomies. Buhl L and Langer J wrote the manuscript. Priglinger SG and Kassumeh S edited the manuscript. The author(s) read and approved the final manuscript.

Conflicts of Interest: Buhl L, None; **Langer J,** None; **Kassumeh S,** None; **Kreutzer TC,** None; **Mayer WJ,** None; **Priglinger SG,** None.

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