ARTICLE

Iris hooks versus a pupil expansion ring: Operating times, complications, and visual acuity outcomes in small pupil cases

Paul Nderitu, MB ChB, MPhil, Paul Ursell, MB BS, MD, FRCOphth

Purpose: To compare iris hooks and a pupil expansion ring (Malyugin ring) in eyes with a small pupil.

Setting: Epsom and St. Helier University National Health Service Trust, London, United Kingdom.

Design: Retrospective case series.

Methods: Patients who had primary phacoemulsification cataract surgery from January 1, 2012, to December 30, 2016, were included. Combined procedures and surgeons with fewer than 50 cases were excluded. Anonymized data were demographics, surgeon grade, case complexity, iris hooks or Malyugin ring use, posterior capsule rupture, zonular fiber rupture or dialysis, vitreous loss, operating time, postoperative complications, and visual acuity.

Results: Of the 9552 cases included, 425 (4.4%) had a small pupil, 314 of which required a pupil expansion ring and 95 iris hooks. Compared with no pupil expander, iris hooks were associated with an additional operating time of 14 minutes for consultants and 24 minutes for trainees. The pupil expansion ring was associated with an additional operating time of 4 minutes and 6 minutes, respectively. Neither pupil expander was associated with more intraoperative complications. The pupil expansion ring was associated with higher postoperative anterior uveitis and corneal edema rates. Pupil expander cases achieved equivalent visual acuity gains.

Conclusions: The pupil expansion ring and iris hooks were safe and effective in minimizing intraoperative complications in eyes with a small pupil. The pupil expansion ring was faster to use than iris hooks. Monitoring for signs of postoperative anterior uveitis or cornea edema with careful insertion or removal of pupil expansion rings is advocated.

J Cataract Refract Surg 2019; 45:167–173 © 2018 ASCRS and ESCRS

Cataract surgery is the most frequently performed operation in the United Kingdom, with approximately 390 000 cataract procedures performed in England alone in 2015 and 2016, an increase from 287 000 procedures in 2005 and 2006.[1–3] Approximately 33% of all National Health Service (NHS) cataract surgery procedures are performed by trainees.[2] It is estimated that 1% to 3% of cataract surgeries are associated with small pupils (<4.0 mm), requiring the use of pupil expanding devices.[4] Small pupils are associated with intraoperative floppy-iris syndrome (IFIS), pseudoexfoliation syndrome, posterior synechiae, and concurrent mitotic therapy use.[4–8] Small pupils are also associated with increased intraoperative complications and twice the odds of posterior capsule rupture (PCR).[9] Management of small pupils can be achieved through pharmacologic iris dilation, surgical techniques, or mechanical iris expansion.[4–8]

Two popular and established mechanical expansion devices are the Malyugin ring and iris hooks.[5,8] The Malyugin ring is a single-piece 5-0 polypropylene injectable iris expander that provides 8 points of contact; it comes in 6.25 mm and 7.00 mm sizes and can fit in a 2.00 mm incision.[5,8] Iris hooks are made of flexible polymers, are manufactured by a number of companies, and are individually inserted through typically 4 to 5 smaller paracenteses (~1.0 mm); variable retraction is applied to each hook to obtain the required pupil size.[8]

This study evaluated the differences in operating time, intraoperative and postoperative complications, and visual acuity outcomes associated with each device, with the inclusion of trainee surgeons.

PATIENTS AND METHODS

Study Data Collection and Patient Selection

All patients who had primary cataract surgery between January 1, 2012, to December 31, 2016, at Epsom and St. Helier NHS trust were included. The study followed the tenets of the Declaration of Helsinki, and anonymized data extraction was used.

Submitted: July 16, 2018 | Final revision submitted: August 6, 2018 | Accepted: August 19, 2018

From the Epsom and St. Helier University National Health Service Trust, London, United Kingdom.

Corresponding author: Paul Nderitu, MB ChB, MPhil, Epsom and St. Helier University National Health Service Trust, Wrythe Lane, Sutton, London, SM5 1AA, United Kingdom. Email: p.nderitu@doctors.org.uk.

© 2018 ASCRS and ESCRS
Published by Elsevier Inc.

0886-3350/$ - see frontmatter
https://doi.org/10.1016/j.jcrs.2018.08.038

The surgical pathway from preoperative assessment to the day of surgery and postoperative visits was standardized for all included patients. Patients who had combined corneal, glaucoma, or retinal procedures (eg, planned vitrectomy) were excluded. Surgeons with fewer than 50 overall cases were also excluded to ensure data from the included surgeons was consistent.

Surgical Technique

Lens removal was performed using standard 2.0 to 2.2 mm clear corneal or limbal incisions, standard phacoemulsification procedures using the Stellaris (Bausch & Lomb, Inc.) or Alcon Constellation (Alcon, Inc.) system, and foldable intraocular lenses. No femtosecond laser–assisted cases were included. A 7.0 mm, 5-0 pupil expansion ring (Malyugin ring, Microsurgical Technology) or 5 flexible polymer iris hooks (Alcon/Grieshaber) and an ophthalmic viscosurgical device (OVD) (sodium hyaluronate 1.0% [Healon]) were used when required. At the time of surgery, the operating surgeon decided whether to use a pupil expander and which of the 2 pupil expanders to use.

Data Collection

For all cases, the baseline demographics, operated eye, biometry measurements, surgeon grade, and intraoperative and postoperative complications recorded on the dedicated electronic medical record (EMR) (Medisoft, Ltd.) were extracted. Data in the EMR on the use of a pupil expander (iris hooks or Malyugin rings) in small pupil cases were extracted. In the majority of cases, a cataract complexity score was recorded using electronic patient management software (iPM, Lorenzo, DXC Technology). The cataract complexity score contained 11 variables associated with PCR (age, male sex, systemic α-blocker use, glaucoma, diabetic retinopathy, axial length [AL], small pupil [$<$4.0 mm], poor positioning, white cataract, no fundus view, and pseudoexfoliation/phacodonesis) as well as other important patient-specific factors and factors associated with reduced postoperative visual acuity.[10] The Medisoft EMR system uses forced data entry and minimizes free text entry; hence, the data were accurate and complete. Because of the requirements on list management, operating times on the iPM system were also recoded for all included cases.

Outcomes

Operating Time Operating time was defined as time out of the surgery suite minus the surgery start time and included the World Health Organization preoperative check, draping, cataract extraction, and undraping; therefore, all relevant surgical events were captured. The median operating time was calculated for each device and compared with that in cases not requiring the use of a pupil expander (as a baseline) stratified by surgeon grade.

Intraoperative Complications Data on any PCR or zonular fiber rupture with or without vitreous loss (defined as any PCR or zonular fiber rupture ± vitreous loss) were extracted from the EMR. A subgroup of patients with a PCR or zonular fiber rupture who had vitreous loss (defined as PCR or zonular fiber rupture + vitreous loss) was also extracted because such patients can have more significant postoperative complications; data on zonular fiber dialysis without vitreous loss were also extracted.

Postoperative Outcomes The patient's distance visual acuity, recorded at the 4-week postoperative visit, was extracted. In patients with a residual uncorrected refractive error, the pinhole visual acuity, where better than the uncorrected distance visual acuity, was used instead. This acuity was termed the distance visual acuity (DVA), and was measured in logarithmic of the minimum angle of resolution (logMAR) notation. Data on the presence of anterior uveitis, cystoid macula edema (CME), corneal edema, and raised intraocular pressure (IOP) ($>$21 mm Hg) were also extracted, the majority of which were noted during the 4-week postoperative visit. All patients who had a visual acuity worse than 6/12 or who had a significant deviation from the preoperative acuity had optical coherence tomography of the macula (Cirrus HD-OCT 4000, Carl Zeiss Meditec AG, or Triton, Topcon Medical Systems, Inc.).

Statistical Analysis

Continuous variables were analyzed as means and standard deviations or medians and interquartile ranges, as appropriate. Dichotomous variables are presented as counts and proportions. Parametric tests for statistical differences were determined using the unpaired *t* test for continuous variables and the chi-square test for dichotomous variables. When multiple *t* tests for the comparison of means were used, the Bonferroni correction of *P* values was applied. When medians are listed, Mann-Whitney *U* nonparametric tests were applied. Cases were stratified into consultants and trainees (includes years 1 to 6 trainees and fellows). All statistical analyses were performed using SPSS software (version 20.0, IBM Corp).

RESULTS

Of 11 067 cases, 9552 (86.3%) had a recorded operating time and sufficient EMR data to be included. Of the 425 cases (4.4%) recorded as having a small pupil, 314 were managed with a Malyugin ring and 95 with iris hooks. Sixteen small pupil cases did not require a pupil expander device and were managed with pharmacologic means or OVDs. Data from 14 consultants and 17 trainees were included.

Table 1 shows the baseline characteristics of cases with iris hooks, pupil expansion ring, or no pupil expander. Patients requiring a pupil expander were significantly older and proportionally more likely to be men. There was no significant difference in the operated eye (right or left). The AL was shorter with a slightly smaller anterior chamber depth in the pupil expander cases, although there was no significant difference between the pupil expansion ring and iris hooks in this regard. For the pupil expansion ring, there were proportionally more consultant cases than in cases needing iris hooks or those with no pupil expander. There was also a greater proportion of intermediate-level trainees in the iris hooks cases.

Operating Time

The median operating time was 16 minutes for consultant and 26 minutes for trainee cases not requiring the use of a pupil expander (Figure 1). However, the Malyugin ring cases were associated with a median operating time of 20 minutes for consultants (additional operating time of 4 minutes compared with no pupil expander cases) and 32 minutes for trainees (additional 6 minutes compared with cases without a pupil expander). Iris hook cases had a significantly longer additional operating time of 30 minutes for consultants (additional 14 minutes compared with no pupil expander cases) and 50 minutes for trainees (additional 24 minutes compared with cases not requiring a pupil expander). There was a significant difference in the operating times between the Malyugin ring cases and iris hook cases for consultants (10-minute difference) and trainees (18-minute difference) (both $P < .001$) (Figure 1).

Table 1. Baseline characteristics of cases with or without a pupil expander.

Variable	No Pupil Expander (A)	Iris Hooks (B)	Malyugin Ring (C)	*P* Value			
				Categorical Variables*	Comparison of Means†		
					A vs B	A vs C	B vs C
Mean age (y)	75	80	80		<.05‡	<.05‡	NS
Sex, n (%)				.001†	—	—	—
Male	3775 (41.3)	50 (52.6)	179 (57)				
Female	5368 (58.7)	45 (47.4)	135 (43)				
Operated eye, n (%)				.299	—	—	—
Left	4339 (47.5)	51 (53.7)	158 (50.3)				
Right	4804 (52.5)	44 (46.3)	156 (49.7)				
Mean AL (mm)	23.54	23.17	23.24		<.05‡	<.05‡	NS
Mean ACD (mm)	3.06	2.78	2.89		<.05‡	<.05‡	NS
Surgeon grade, n (%)				.001*	—	—	—
Consultants	6421 (70.2)	66 (69.5)	258 (82.2)				
Trainee year 1–2	842 (9.2)	3 (3.2)	14 (4.5)				
Trainee year 3–4	955 (10.4)	18 (18.9)	29 (9.2)				
Trainee year 5–6	429 (4.7)	7 (7.4)	7 (2.2)				
Fellows	496 (5.4)	1 (1.1)	6 (1.9)				
Mean complexity score	4	7	7	—	<.05‡	<.05‡	NS

ACD = anterior chamber depth; AL = axial length; NS = not significant
*Chi-square test
†*t* test; Bonferroni correction applied for pairwise comparison of means
‡Statistically significant ($P \leq .05$)

Intraoperative Complications

Table 2 shows intraoperative complications and operating time associated with pupil expander use. Posterior capsule rupture or zonular fiber rupture with or without vitreous loss occurred in 9 cases (2.3%) requiring any pupil expander and in 130 cases (1.4%) not requiring a pupil expander. There were proportionally more cases with a PCR or zonular fiber rupture with or without vitreous loss in the iris hook group than in the Malyugin ring or pupil expander group; however, the difference was not statistically significant. A similar finding was seen when only cases with PCR or zonular fiber rupture with vitreous loss were examined. There was a higher proportion of zonular fiber dialysis in cases with a pupil expander ($P = .016$) but no significant difference in the occurrence of zonular dialysis between the iris hooks cases and Malyugin ring cases. Overall, however, the occurrence of zonular fiber dialysis in pupil expander cases was small (5 cases [1.2%]).

In eyes in which no pupil expander was used, the occurrence of a PCR resulted in a significant increase in operating time compared with cases without a PCR. However, there was as an additional increase in operating time in cases with a PCR that required a pupil expander compared with cases with a PCR not requiring a pupil expander. In addition, cases complicated by a PCR requiring the use of iris hooks took significantly longer than PCR cases with the use of a Malyugin ring. Zonular fiber dialysis cases also took significantly longer

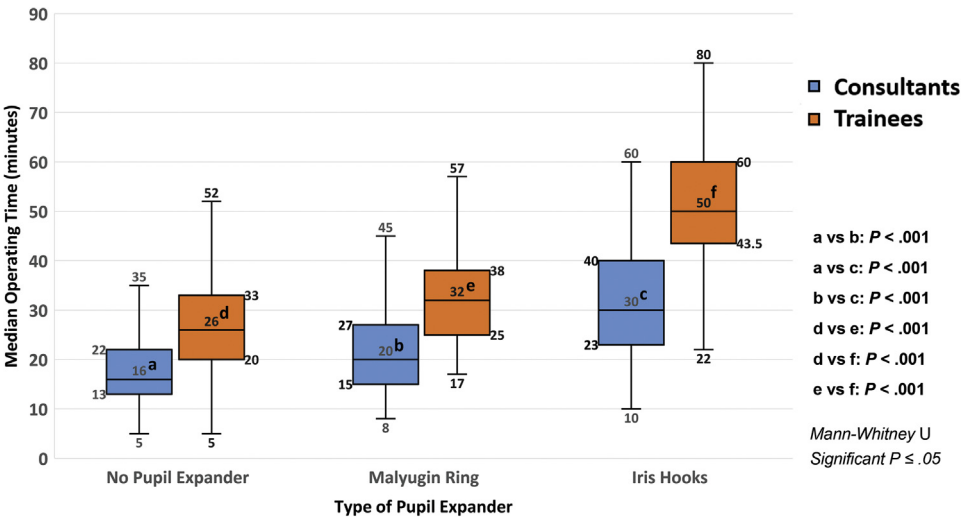


Figure 1. Median operating time by pupil expander device.

Table 2. Intraoperative complications and operating time (minutes) associated with pupil expander use.

	No Pupil Expander		Iris Hooks	
Variable	n (%)	Operating Time (A)	n (%)	Operating Time (B)
Any PCR/ZR ± VL				
Yes	130 (1.4)	47	4 (4.2)	91
No	9013 (98.6)	21	91 (95.8)	37
PCR/ZR with VL				
Yes	96 (1.0)	49	3 (3.2)	93
No	9047 (99.0)	21	92 (96.8)	38
ZD				
Yes	31 (0.3)	33	1 (1.1)	77
No	9112 (99.7)	21	94 (98.9)	39
Endothelial damage				
Yes	12 (0.1)	—	0	—
No	9131 (99.9)	—	95 (100)	—

NA = not applicable; PCR = Posterior capsular rupture; VL = vitreous loss; ZD = zonular fiber dialysis; ZR = Zonular fiber rupture
*Chi-square test
†*t* test; Bonferroni correction applied for pairwise comparison of means
‡Statistically significant ($P \leq .05$)

in the iris hook group than in the pupil expansion ring group.

There were no recorded anterior capsule tears with either pupil expansion device. However, the proportion of endothelial damage was higher with the Malyugin ring, with 2 of 3 such events occurring in the trainee group.

Postoperative Complications

The proportion of patients with anterior uveitis and corneal edema was significantly higher in the Malyugin ring group than in those cases requiring iris hooks or no pupil expander. The proportion of raised postoperative IOP was higher in patients requiring iris hooks, although this did not reach statistical significance. There was no significantly increased risk for CME with use of pupil expanders (Table 3).

Visual Acuity Outcomes

There was no statistically significant difference in preoperative logMAR DVA between pupil expander cases and no pupil expander cases (Table 3). Cases with a pupil expansion ring and those with iris hooks gained on average 0.39 logMAR DVA (~20 letters) after cataract extraction; however, patients requiring no pupil expander had better a postoperative mean DVA. This is reflected by the fact that a greater proportion the group with no pupil expander had a higher proportion of patients with a DVA better than 6/12, although there was a slightly higher proportion of such patients in the pupil expansion ring group than in the iris hooks group. However, cases requiring a pupil expander had a higher mean complexity score (Table 1), which incorporates factors associated with a reduced postoperative visual acuity, and hence ocular comorbidity; thus, the use of the pupil expander was not the likely cause of the observed association.

DISCUSSION

This study examined intraoperative and postoperative performance indicators in regard to complications, operating time, and visual acuity outcomes between 2 of the most popular mechanical pupil expansion devices. The use of a pupil expander increases operating time, and our study found that the Malyugin pupil expansion ring added significantly less operating time in the hands of both consultants and trainees compared with the use of iris hooks in uneventful and in complicated cases. There also appears to be a notable trainee effect, with much higher operating time when cases requiring iris hooks were performed by trainees. This effect was present despite both groups having similar complexity scores and approximately similar baseline characteristics. Although the Malyugin ring has been proposed to be faster to use than iris hooks,[6] our study provides quantitative evidence of this effect in both consultants and trainees. Iris hooks have also been reported to take longer to use than the Morcher pupil ring.[11] The occurrence of a PCR or zonular fiber dialysis in a case requiring iris hooks resulted in a much longer operating time than similar complex cases in which the Malyugin pupil expansion ring was used; this has not previously been reported.

A consideration when deciding on the use of a pupil expander is the cost of the device, which is relatively higher per case for the Malyugin ring; in addition, some iris hooks are reusable. However, the reduced operating time with the Malyugin ring would also affect operating costs and both devices are equivalent in reducing risks related to PCR or zonular fiber rupture.

Encouragingly, although cases requiring pupil expanders are more complex, there is not a significant increase in PCR or zonular fiber rupture when an appropriately competent surgeon performed the cases. There was a higher incidence of endothelial damage with pupil expansion ring cases,

Table 2. (Cont.)

Malyugin Ring		*P* Value			
			Mean Operating Time†		
n (%)	Operating Time (C)	Intraop Complication*	A vs B	A vs C	B vs C
		.076	<.05‡	<.05‡	<.05‡
5 (1.6)	58				
309 (98.4)	24				
		.098	<.05‡	<.05‡	<.05‡
5 (1.6)	58				
309 (98.4)	28				
		.016	<.05‡	<.05‡	<.05‡
4 (1.3)	38				
310 (98.7)	24				
		.001	NA	NA	NA
3 (1.0)	—				
311 (99.0)	—				

which indicates that careful removal of the device should be a focus. However, data on whether this damage occurred as a result of pupil expansion ring use were not available. Low incidences of intraoperative complications have been reported both with the use of iris hooks and the Malyugin ring.[6,11] The occurrence of zonular dialysis is likely a reflection of the complexity of the cases and less likely a direct result of the use of a pupil expander. Some surgeons might prefer to use iris hooks in such cases to provide additional stability to the capsular bag intraoperatively.[8,12] Iris hooks, however, require more corneal incisions; thus, additional steps to ensure wound integrity might be required.

There are limited data on the occurrence of postoperative complications with the use of iris hooks or Malyugin rings.

Table 3. Postoperative complications and visual acuity outcomes associated with pupil expander use.

Variable	No Pupil Expander (A)	Iris Hooks (B)	Malyugin Ring (C)	*P* Value			
				Categorical Variables*	Comparison of Means†		
					A vs B	A vs C	B vs C
Anterior uveitis, n (%)				<.001‡	—	—	—
Yes	236 (2.6)	1 (1.1)	21 (6.7)				
No	8907 (97.4)	94 (98.9)	293 (93.3)				
CME, n (%)				.391	—	—	—
Yes	174 (1.9)	1 (1.1)	9 (2.9)				
No	8869 (98.1)	94 (98.9)	305 (97.1)				
Corneal edema, n (%)				<.001‡	—	—	—
Yes	165 (1.8)	2 (2.1)	22 (7.0)				
No	8978 (98.2)	93 (94.7)	292 (96.5)				
Raised IOP (>21 mm Hg), n (%)				.052	—	—	—
Yes	204 (2.2)	5 (5.3)	11 (3.5)				
No	8939 (97.8)	90 (94.7)	303 (96.5)				
DVA (logMAR)							
Mean preop	0.64	0.77	0.66	—	NS	NS	NS
Mean postop	0.19	0.37	0.26	—	<.05‡	<.05‡	NS
Mean improvement	0.45	0.39	0.39	—	NS	NS	NS
<0.3 (Snellen >6/12), n (%)				<.001‡	—	—	—
Yes	7076 (85.9)	62 (74.4)	234 (78.8)				
No	1160 (14.1)	21 (25.3)	63 (21.2)				

CME = cystoid macular edema; DVA = distance visual acuity; IOP = intraocular pressure; logMAR = logarithm of the minimum angle of resolution; NS = not significant

*Chi-square test

†*t* test; Bonferroni correction applied for pairwise comparison of means

‡Statistically significant ($P \leq .05$)

In our study, the occurrence of corneal edema and postoperative anterior uveitis was higher with the pupil expansion ring than with iris hooks. The occurrence of endothelial damage was also higher with the use of the Malyugin ring, which might explain the higher postoperative corneal edema rates. However, the occurrence of PCR or zonular fiber rupture was low in both groups, and more cases in the pupil expansion ring group were performed by consultants with complexity scores similar to those with iris hooks cases. Both iris hooks and Malyugin rings have been reported to be associated with iris sphincter damage, which can induce postoperative anterior uveitis with subsequent corneal edema.[6,8,11] Because iris hooks allow for a graduated amount of retraction while Malyugin ring has a fixed diameter,[6,8] careful insertion and removal of the Malyugin ring (and iris hooks) should be a priority to minimize intraoperative and postoperative issues. When there has been a degree of manipulation of the iris during insertion or removal of either device, use of extended postoperative steroid drops or subconjunctival steroids should also be considered. However, outcomes might be influenced by the correlation of the surgeon, comorbidity, and choice of pupil expander (eg, a glaucoma consultant preferring iris hooks and hence patients with a propensity for raised postoperative IOP). There was no significant difference in the occurrence of raised IOP postoperatively, matching the results in a previous small study[A]; no increased risk for CME with the pupil expansion ring was noted.

With use of either pupil expander, there were equal improvements in the mean visual acuity from baseline. There was a slightly greater proportion of patients achieving 6/12 or better with the Malyugin ring than patients receiving iris hooks; however, the use of a pupil expander was associated with lower postoperative vision. This is likely a consequence of the higher associated ocular comorbidity in the pupil expander group, which had higher mean complexity scores. Our study agrees with previous comparisons between iris hooks and Malyugin rings, showing no significant differences in postoperative visual acuity at 1 month.[A]

Regarding strengths and limitations, this study used EMRs from a single NHS trust with forced data entry and hence had accurate surgical records with high completion rates. The study also had the largest sample of Malyugin ring and iris hooks cases published and data on surgeons at all levels of practice, allowing training effects to become apparent. This study also evaluated in detail important intraoperative and postoperative factors as well as visual outcomes, finding overall efficacy and safety of both devices.

The limitations of this study are that operating time included all actions performed from the time the patient was in the operating room until he or she left; hence, the total operating time might vary because of other factors. However, because all safety-related procedures and preparatory actions are performed nearly identically in all cases, the large majority of the variability in operating time lies in the operative procedures. We did not specifically evaluate the use of pharmacologic or OVD use in small pupil cases; however, had these been sufficiently successful, mechanical pupil expansion would not have been necessary. We did not have data on the reasons for the choice of each particular mechanical pupil expander, although the majority of consultants had a particular preference or experience with either iris hooks or Malyugin rings. We were not able to qualify the decision-making process that resulted in the use of a mechanical pupil expander. However, subjectively each surgeon would factor the likelihood of safely completing a small pupil case or preempt complications such as IFIS in their decision-making process to use a mechanical pupil expander as well as the behavior of the other eye in second cataract surgery. We therefore do not believe that the previous use of such strategies had a significant impact on the intraoperative or postoperative outcomes studied in such a way as to create systematic bias toward either device. We believe that this is the largest observational study to date to compare iris hooks and Malyugin rings with one aim being to minimize the risk for bias in results with the available data.

In conclusion, both the Malyugin pupil expansion ring and iris hooks are safe and effective in minimizing intraoperative complications associated with the occurrence of small pupils. The use of the Malyugin ring for small pupil cases was faster than the use of iris hooks, especially when a trainee is operating. Monitoring for signs of postoperative anterior uveitis or cornea edema and careful insertion and/or removal of the Malyugin ring is advocated.

WHAT WAS KNOWN

- Use of mechanical pupil expanders (eg, iris hooks and pupil expansion rings) are effective in reducing intraoperative risks associated with small pupils.

WHAT THIS PAPER ADDS

- Iris hook cases took on average 10 minutes longer than Malyugin ring cases among consultants and 18 minutes among trainees.
- Both pupil expanders achieved equivalent visual acuity gains; however, there was a comparative increased risk for postoperative anterior uveitis and corneal edema in eyes with a Malyugin ring.

REFERENCES

1. Sparrow JM, Taylor H, Qureshi K, Smith R, Johnston RL, the UK EPR User Group. The cataract national data set electronic multi-centre audit of 55 567 operations: case-mix adjusted surgeon's outcomes for posterior capsule rupture. Eye 2011; 25:1010–1015
2. Jaycock P, Johnston RL, Taylor H, Adams M, Tole DM, Galloway P, Canning C, Sparrow JM, the UK EPR User Group. The Cataract National Dataset electronic multicentre audit of 55 567 operations: Updating benchmark standards of care in the United Kingdom and internationally. Eye 2009; 23:38–49
3. Donachie PHJ, Sparrow JM. National Ophthalmology Database Audit. Year 2 Annual Report – The First Prospective Report of the National Ophthalmology Database Audit 2017. London, UK, Royal College of Ophthalmologists, 2017
4. Halkiadakis I, Chatziralli I, Drakos E, Katzakis M, Skouriotis S, Patsea E, Mitropouos P, Kandarakis A. Causes and management of small pupil in patients with cataract. Oman J Ophthalmol 2017; 10:220–224
5. Malyugin B. Cataract surgery in small pupils. Indian J Ophthalmol 2017; 65:1323–1328

6. Chang DF. Use of Malyugin pupil expansion device for intraoperative floppy-iris syndrome: results in 30 consecutive cases. J Cataract Refract Surg 2008; 34:835–841
7. Kaštelan S, Tomić M, Kordić R, Kalauz M, Salopek-Rabatić J. Cataract surgery in eyes with pseudoexfoliation (PEX) syndrome. J Clin Exp Ophthalmol 2013; S1:009
8. Lee BS, Chang DF. Management of small pupils. Expert Rev Ophthalmol 2016; 11:49–58
9. Narendran N, Jaycock P, Johnston RL, Taylor H, Adams M, Tole DM, Asaria RH, Galloway P, Sparrow JM. The Cataract National Dataset electronic multicentre audit of 55 567 operations: risk stratification for posterior capsule rupture and vitreous loss. Eye 2009; 23:31–37
10. Nderitu P, Ursell P. Updated cataract surgery complexity stratification score for trainee ophthalmic surgeons. J Cataract Refract Surg 2018; 44:709–717
11. Akman A, Yilmaz G, Oto S, Akova YA. Comparison of various pupil dilatation methods for phacoemulsification in eyes with a small pupil secondary to pseudoexfoliation. Ophthalmology 2004; 111:1693–1698
12. Goldman JM, Karp CL. Adjunct devices for managing challenging cases in cataract surgery: pupil expansion and stabilization of the capsular bag. Curr Opin Ophthalmol 2007; 18:44–51

OTHER CITED MATERIAL

A. Hanna J, Kalbag N, Khouri AS, "Visual Outcomes After Uncomplicated Complex Cataract Surgery: Malyugin Ring Versus Iris Hooks," presented at the annual meeting of the Association for Research in Vision and Ophthalmology, Orlando, Florida, USA, May 2014. Abstract available in Invest Ophthalmol Vis Sci 2014; 55:2812. Available at: https://iovs.arvojournals.org/article.aspx?articleid=2268175. Accessed October 4, 2018

Disclosures: *None of the authors has a financial or proprietary interest in any material or method mentioned.*



First author:
Paul Nderitu, MB ChB, MPhil

Epsom and St. Helier University NHS Trust, London, United Kingdom