Cataract surgery in small adult eyes

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ABSTRACT

Aim To evaluate the clinical outcomes of phacoemulsification cataract surgery in microphthalmos.
Methods Retrospective consecutive case series of eyes with axial length <20.9 mm, and requiring a high intraocular lens (IOL) power ($\geq$30 or $\geq$35 dioptres for anterior or posterior chamber fixation, respectively), with no history of previous ocular surgery, and undergoing planned phacoemulsification cataract surgery with IOL implantation at Moorfields Eye Hospital was investigated to observe the incidence of intraoperative and postoperative complications.
Results During a 5-year study period, 47 of 22 093 eyes were treated in two locations (0.21%). Thirty-nine eyes met the study inclusion criteria. No serious intraoperative adverse events were recorded. Severe postoperative complications (retinal detachment and chronic postoperative uveitis) occurred in two cases. The postoperative corrected distance visual acuity (CDVA) was logMAR 0.30 or better in 24 eyes (62%), and only three eyes obtained worse vision. The overall ocular comorbidity rate was 53%; 10 microphthalmic eyes (26%) presented with associated congenital or hereditary pathology, and had worse visual outcomes (p<0.0001).
Conclusions Microphthalmic eyes requiring high IOL power are rare, and their presence is often associated with other ocular congenital or acquired disorders. Overall, the clinical outcomes were satisfactory and the surgical procedure affected by a low complication rate.

INTRODUCTION

High rates of severe perioperative complications are reported for cataract surgery in small adult eyes.[1] However, the evidence on this topic is very limited, and mainly formed by small case series, which inevitably are of limited scientific value as significantly underpowered for the purpose of estimating the rate of the rare complications in cataract surgery. Additionally, differences in the inclusion criteria do not allow meta-analysis of the available data.

The recent study from Day and associates,[2] the largest series available, indicated the reduced anterior chamber depth and the short axial length (AL) as factors responsible for the increased rates of perioperative complications in their patients.

While the safety of the surgical procedure is always carefully discussed, this topic is of paramount importance at the time of counselling patients with microphthalmic eyes for cataract surgery. In fact, a large proportion of these may consider or might be advised to undergo phacoemulsification cataract surgery when they are not yet affected by visually advanced lens opacities: removing a clear lens might be suggested to improve intraocular pressure control without encountering the more serious and frequent complications of fistulising glaucoma surgery[3 4]; or it might represent a valuable treatment option for the refractive correction of significant degrees of hyperopia, in light of the limited alternatives.[5 6]

The purpose of our retrospective study was to investigate the surgical and clinical outcomes of standard phacoemulsification cataract surgery in small adult eyes treated at a large tertiary referral hospital.

MATERIALS AND METHODS

Institutional review board approval was obtained for this retrospective audit, and precautions were taken to protect the identity of the study patients. The research adhered to the tenets of the Declaration of Helsinki.

In order to identify microphthalmic eyes undergone cataract surgery at Moorfields Eye Hospital (main hospital) and Moorfields St Ann's Cataract Centre during a 5-year period (January 2006–December 2010), a surgical logbook search was performed. Searching criteria were intraocular lens (IOL) power greater than 30 dioptres (D) for anterior chamber-fixated IOLs and greater than 35 D for posterior chamber-fixated IOLs. Additionally, we searched for secondary IOL implantation procedures and examined the notes of patients who had been left aphakic following the primary surgery to identify microphthalmic eyes that may have not received an intraocular implant at the time of their phacoemulsification cataract surgery. Exclusion criteria were greater AL (AL>20.9 mm), previous ocular surgery, any other associated intraoperative surgical procedure apart from cataract extraction with IOL implantation, history of uveitis, and surgeon in training (table 1).

The data collection included preoperative examinations, operative details and postoperative findings (tables 2–5).

Table 1 Patient selection

Eyes identified (during the 5-year period)	47
Eyes excluded	
Previous PPV	1
Concomitant PPV	1
Previous glaucoma surgery	1
Previous LASIK	1
AL >20.9	1
Junior surgeon	3
Eye included in the study	39

AL, axial length; PPV, pars plana vitrectomy.

Table 2	Demographics and preoperative data (39 eyes)
Sex (male/female)	14/25
Laterality (right/left)	16/23
Age (years)	
Mean±SD	65.6±17.5
Range	22–93
Preoperative SE (D)	
Mean±SD	+9.07±2.51
Range	+3.00/+16.37
Preoperative corneal power (D)	
Mean±SD	43.82±2.30
Range	38.67–48.85
Axial length (mm)	
Mean±SD	19.51±1.15
Range	15.84–20.64
Anterior chamber depth (mm)	
Mean±SD	2.52±0.45
Range	1.88–3.85
Median	2.44
IOL power (D)	
Mean/median	37.0/36.0
Range	35–49

IOL, intraocular lens; SE, spherical equivalent.

For the purpose of this study, we considered posterior capsule rupture (PCR), iatrogenic zonular dialysis, and suprachoroidal haemorrhage as severe intraoperative adverse events. Uveal effusion, acute retinal detachment (within 1 month of cataract surgery), chronic endothelial disease requiring surgery, and visually significant (vision<LogMAR 0.30) chronic cystoid macular oedema and endophthalmitis were defined as severe postoperative complications.

In line with practice patterns in use elsewhere, a day-1 postoperative review is not performed in case of uncomplicated cataract surgery; accordingly, the first follow-up examination was performed 1–3 weeks after surgery. Postoperative visual acuity and refraction were recorded 3–4 weeks after surgery for uncomplicated cases, or at discharge in case of any complications. In line with the current recommendations of the Royal College of Ophthalmologists Cataract Surgery Guidelines in the UK,[7] and with our institutional guidelines, the Hoffer-Q formula was used to determine the required IOL power in all cases.

Table 3	Intraoperative data	
		Number
Type of IOL		
SA60AT		37
Xtreme D		2
Type of anaesthesia		
Topical		3
Subtenons		32
General		4
Surgeons grade		
Consultant		23
Fellow (expert trainee)		16
Iris retractors use		7

IOL, intraocular lens.

Table 4	Perioperative complications	
No complications		35 (90%)
Iris prolapse with iris trauma		1
Endothelial corneal touch		1
Anterior capsule tear		–
Uveal effusion		–
Retinal detachment		1
Prolonged corneal oedema		–
Marked postoperative inflammation (temporary)		2
Chronic iritis		–
Chronic corneal oedema		–
Chronic cystoid macular oedema		1

The fractional acuity notations obtained on English Snellen optotypes charts were converted to logarithm of minimum angle of resolution (logMAR) for the statistical analysis.

Surgical technique and postoperative treatment

A standard 3.2 mm clear corneal incision phacoemulsification cataract surgery and implantation of a single IOL was performed in all cases, using either the Legacy or the Infinity phacoemulsification systems (Alcon, Forth Worth, Texas, USA). A number of experienced ophthalmic surgeons (consultants and fellows only) performed the surgical interventions using a variety of nucleofractis techniques and phaco/fluidics settings. The anaesthetic technique varied from topical to general anaesthesia, according to patients and their ocular conditions, and surgeons' preferences.

A standard postoperative therapeutic regimen was adopted, consisting of topical dexamethasone 0.1% and chloramphenicol 0.5% four times daily for the first 2 weeks; the topical steroidal treatment was then tailed off as needed. If iris manipulation was performed to release posterior synechiae, or iris retractors were used, or if there was iris trauma, additional topical non-steroidal anti-inflammatory ketorolac 0.5% was prescribed four times daily for a month. By contrast with previous studies, prophylactic medical treatments were not adopted in any case.

Statistical analysis

For the descriptive statistics, we calculated mean, median, quartiles and range of values as appropriate. The Shapiro normality test was performed, and the SPSS software (V.19.0, SPSS) used for statistical analysis. The Fisher exact test, the Mann–Whitney U test, and the Wilcoxon signed rank test were used as appropriate. A p value less than 0.05 was considered statistically significant.

Table 5	Associated ocular disease (51% of studied eyes)	
Congenital/hereditary pathology (10 eyes)		
Leber congenital amaurosis		1
Oculocutaneous albinism		2
Retinal coloboma		1
Congenital cataract		1
Retinitis pigmentosa		3
Corneal dystrophy		2
Acquired associated pathology		
Chronic angle closure glaucoma		6
Pseudoexfoliation syndrome		2
Diabetic maculopathy		1
Fuchs dystrophy		1

RESULTS

In a 5-year period, we identified 47 consecutive eyes requiring a posterior chamber implant with a power of 35 D or greater (table 1), and 39 met the selection criteria. In all the 47 eyes identified, the IOL had been implanted in the capsular bag. There were no cases of primary or secondary surgery for the implantation of an anterior chamber (AC)-IOL of 30 D power or more, and in no cases IOLs were implanted in the ciliary sulcus. During the study period, none of the eyes left aphakic at the time of primary intervention had an AL shorter than 20.9 mm.

Tables 2–5 report the demographic data, perioperative details, and associated ocular comorbidities. The mean age of the recruited patients was 65.6 years±17.5 (range 22–93), with nine patients younger than 45 (23%), and the female sex representing the majority (64%). The mean preoperative spherical equivalent was +9.07 D±2.51 SD (range +3.00–+16.37 D). The mean AL was 19.51 mm±1.15 (range 15.84–20.64 mm, median 19.94 mm), with a mean anterior chamber Depth (ACD) of 2.52 mm±0.45 (range 1.88–3.81 mm, median 2.44 mm).

In all cases, a single-piece acrylic IOL was successfully implanted in the capsular bag, as planned.

The intraoperative complications observed were iris trauma in one case and corneal endothelium-descemet membrane mechanical damage in a further case. No other intraoperative complications were described. Postoperative complications are detailed in table 4.

Associated ocular comorbidity was observed in 20 eyes (in 10 eyes, microphthalmos was associated with congenital or hereditary disorders), with an overall comorbidity rate of 51%.

Visual and refractive outcomes

The visual outcomes are displayed in table 6: of the 39 eyes, 2 eyes (4%) lost 1 or 2 lines of logMAR visual acuity due to retinal detachment and chronic cystoid macular oedema, and 10 eyes (26%) gained 3 or more lines of corrected distance visual acuity (CDVA). Eyes with unchanged visual acuity or improved by less than 3 lines (27 eyes, 71%) underwent surgery for non-advanced lens opacities with a view to improving the intraocular pressure control or as a refractive procedure: in 14/27 the preoperative CDVA was ≥logMAR 0.20, in 7/27 ≤logMAR 1.00, and in the other 6/27 cases the CDVA was >logMAR 1.00 and <logMAR 0.20. Overall, a final visual acuity of ≥logMAR 0.20 or ≥logMAR 0.30 was achieved in 47% and 53% of the eyes, respectively.

The mean postoperative CDVA was logMAR 1.40±1.08 in 10 eyes that were affected with associated ocular congenital or hereditary disease, whereas a mean CDVA of logMAR 0.33±0.29 was observed in the remaining 29 eyes presenting without associated ocular disease (19 eyes) or with acquired associate ocular pathology (10 eyes), with a significant difference between these two subgroups (p<0.001).

Overall, the mean postoperative refraction was −0.70 ±2.11 D, with an mean numerical error (MNE) of 0.92 ±2.55 D. Eleven of the 39 eyes enrolled in the study (28%) had a final refraction within 0.5 D of target, and 18 eyes (50%) had a postoperative refraction within 1 D of target.

In five cases (13%), the final refraction was beyond target by more than 2 D.

DISCUSSION

In our experience, modern phacoemulsification cataract surgery in small adult eyes appeared to be safe, as no severe intraoperative complications were encountered. We observed a relatively low rate of perioperative complications (table 4), despite the variety of nucleofractis techniques and phaco/fluidics settings employed by a multiplicity of surgeons. It was somehow interesting to note that the rate of intraoperative complications was lower than in previously reported single-surgeons series.

Yuzbasioglu and associates reported the need to convert phacoemulsification cataract surgery to manual extracapsular cataract surgery in 25% of the cases they treated, with a case of PCR and a further eye that was left aphakic.[8] Later, Jung and associates observed a PCR rate of 11% in a single-surgeon case-series.[9] More recently, Steijns et al[10] reported a PCR rate of 7% with two eyes left aphakic, and also observed uveal effusion in two other cases; however, they included surgical procedures performed as early as 1990.

The latest study from Day et al also reported a rate of complications higher than average, with no cases of PCR and 5% rate of intraoperative marked zonular dialysis; in their study, previous intraocular surgery was not an exclusion criterion.[2]

Anyhow, the outcomes reported in recent years were certainly more favourable than those observed with intracapsular cataract extraction technique, when cataract surgery in microphthalmos was regarded as a last resort, in light of the unacceptably high rates of intraoperative and postoperative complications.[11]

We argue that the difference in surgical techniques employed over the past decades in cataract surgery might only partially explain the great discrepancies in the rate of complications reported for cataract surgery in microphthalmos. Additional causes for the large variability of the surgical outcomes may include: the lack of consensus on the definition of microphthalmos/nanophthalmos,[2] leading to the selection of different study populations; the lack of control for anterior chamber depth in the majority of the case-series; and the inclusion of eyes previously undergone intraocular surgery, which carries a higher risk of surgical complications in normal and myopic eyes alike. Finally, consideration deserves also the sample size of all the case series published to date, which were underpowered for the accurate estimation of the true incidence of the rare severe intraoperative and postoperative complications of cataract surgery.

In fact, a power sample calculation showed that, for a α value=0.05, the required sample size would be n=122 or n=254 for a power of 80% and 95%, respectively.

The considerations we based this estimation upon were that (1) the rate of intraoperative capsule complications with or without vitreous loss for the whole cataract population analysed in the Cataract National Dataset in the UK (no exclusion criteria) was 1.92%[12]; (2) the vast majority of these procedures were routine phacoemulsification cataract surgery performed by any surgeon; (3) the rate of complications is higher when less experienced surgeons (lower surgical volume) performed surgery (same study); we can infer that more experienced surgeons would be operating small eyes, given the previous evidence that cataract surgery in these eyes yields higher rates of complications.

According to the above considerations, a complication rate three times higher (1.92%×3=5.76%) with a SD of 1.92 may be considered higher than the reported standard rate, and due to nanophthalmos.

With regards to the definition of nanophthalmos, Weiss suggested to adopt an axial length value smaller than 20.9 mm to define small adult eyes,[13] a definition that represents an AL shorter than average by two SD values, which has been accepted by others.[14]

Another source of possible inconsistencies throughout the available studies is the lack of information on AC depth, even though a shallow AC has been often indicated as one of the

Table 6 Visual acuity, ocular comorbidity, and indication to surgery

	Preoperative CDVA (logMAR)	Postoperative CDVA (logMAR)	Visual acuity lines differential	Congenital ocular comorbidity	Acquired ocular comorbidity	Indication for surgery
Case 1	0.22	0.20	0		*	Improving IOP control
Case 2	0.20	0.18	0		*	Improving IOP control
Case 3	0.30	0.20	1	*		Refractive correction
Case 4	1.30	1.24	0	*		Improving IOP control
Case 5	0.48	0.48	0		*	Improving IOP control
Case 6	0.66	0.72	0			Refractive correction
Case 7	1.00	0.60	4		*	Significant lens opacities
Case 8	0.76	0.58	2	*		Significant lens opacities
Case 9	0.30	0.28	0		*	Improving IOP control
Case 10	0.16	0.20	0			Refractive correction
Case 11	0.50	0.18	3			Significant lens opacities
Case 12	0.78	1.00	−2	*		Improving IOP control
Case 13	0.30	0.00	3			Significant lens opacities
Case 14	0.00	0.00	0			Refractive correction
Case 15	2.50	0.30	10			Significant lens opacities
Case 16	0.78	0.60	2	*		Significant lens opacities
Case 17	1.00	0.78	2	*		Significant lens opacities
Case 18	0.20	0.00	2			Improving IOP control
Case 19	0.20	0.20	0			Improving IOP control
Case 20	0.30	0.20	1			Refractive correction
Case 21	0.30	0.20	1			Refractive correction
Case 22	1.00	1.00	0			Significant lens opacities
Case 23	0.50	0.20	3		*	Improving IOP control
Case 24	1.00	0.76	2			Significant lens opacities
Case 25	0.60	0.20	4			Significant lens opacities
Case 26	0.30	0.00	3		*	Improving IOP control
Case 27	0.36	0.50	−1	*		Improving IOP control
Case 28	0.48	0.20	3		*	Improving IOP control
Case 29	1.20	0.52	3			Significant lens opacities
Case 30	0.22	0.20	1		*	Refractive correction
Case 31	0.16	0.20	0		*	Refractive correction
Case 32	0.48	0.20	0			Improving IOP control
Case 33	0.30	0.20	1			Improving IOP control
Case 34	0.60	0.30	3	*		Refractive correction
Case 35	2.00	2.00	0	*		Improving IOP control
Case 36	0.48	0.20	3			Significant lens opacities
Case 37	2.00	2.00	0	*		Improving IOP control
Case 38	0.60	0.50	2			Improving IOP control
Case 39	0.30	0.36	0			Improving IOP control

*Yes.
CDVA, corrected distance visual acuity; IOP, intraocular pressure.

main responsible factors for the increased rates of intraoperative complications in microphthalmos cataract surgery. Day and associates have been the first to show a strong relation between shallow AC or short AL (shorter than 20.0 mm) and perioperative complications[2]; however, eyes previously undergone intraocular surgery were not excluded, and the rate of 'any' complications was investigated instead of capsule complications or other severe complications. This might significantly change the perspective, as only the severe complications are regarded as quality indicators in cataract surgery and have the potential to prolong the surgical time, extend the postoperative course, and eventually jeopardise the final visual acuity. Therefore, the study from Day et al might also indirectly inform on the relatively low rate of severe intraoperative complications.

In our study, the complications were even lower, though a larger percentage had AL shorter than 20.0 mm (24 eyes, 62%) and shallower AC (median value 2.44 mm) in our sample.

Should a shallow and narrow anterior segment determine or induce in some ways higher rates of complications, this would be independent from the AL, and any eye with a shallow AC should be more prone to intraoperative complications. To test this hypothesis, we obtained data from a previous clinical audit performed at our institution on this topic (data not published): among 53 eyes with AL >20.9 mm and ACD<2.40 mm operated on by experienced cataract surgeons, no severe complications were encountered. Hence, these observations may query the role of shallow AC as a contributing factor for surgical complications when experienced surgeons perform phacoemulsification cataract surgery in microphthalmic eyes. Other factors, such as poor intraoperative mydriasis and zonular abnormalities often seen in these eyes, might represent more challenging factors.

The choice of anaesthesia and the adoption of surgical or medical prophylactic interventions is also controversial.

Previously described prophylactic measures include: limited 1-port pars plana anterior vitrectomy, to deepen the anterior chamber[15]; preoperative acetazolamide and oral steroidal treatment during the 24 h preceding surgery, to reduce the risk of intraoperative and postoperative uveal effusion syndrome[16]; preoperative intravenous administration of Mannitol 20%, to maximise the anterior chamber depth[9 17]; and scleral decompression, with a view to preventing the risk of exudative retinal detachment secondary to uveal effusion.[18]

In particular, Stejins et al reported that nearly half their patients had been treated either with acetazolamide or mannitol, that oral prednisolone was used in 13 of the 43 patients, and that pars plana anterior vitrectomy was performed in 14% of cases. They also described a favourable effect of systemic diuretics on the anterior chamber depth.[10] Though this is possible, the authors did not specify how they objectively measured the positive effect of these measures. In our study, no prophylactic measures were adopted, and the anaesthetic techniques differed from general to topical anaesthesia according to the ocular and systemic conditions, and the surgeons' preferences: topical anaesthesia was the least preferred option, and local subtenons anaesthesia the most used technique (table 3). Instead, some authors have indicated the topical anaesthesia as the preferred option,[16] and consider regional blocks at an increased risk of positive posterior pressure.[8 16]

In our series, we confirmed that microphthalmic eyes are extremely rare among the cataract population (0.2%) and associated with a high comorbidity rate. Apart from cases affected with refractive amblyopia, visual outcomes were satisfactory only in those patients who did not suffer from ocular congenital or hereditary ocular disorders.

The limitations of this study are mainly related to the retrospective design: our methodology may have failed to capture all small adult eyes treated at the two investigated sites, being the search targeted at intraocular implants of at least 35 D power (or at least 30 D if ACIOL), this could have left unrecognised microphthalmic eyes with higher corneal powers receiving less powerful IOLs, or eyes with polipseudophakia. In our series, we had a relatively small percentage of eyes with AL shorter than 18.0 (11%) which have been associated with higher complication rates following cataract surgery,[19] therefore, the lower rate of postoperative complications might also be related to the reduced number of high-risk eyes in the study population we had. In this regard, we suggest to adopt a new definition of extreme microphthalmos (eyes with a AL shorter than average by 4 SD values) to be used in future studies. Finally, an important limitation of this study lies in the sample size: as for all the other previously published series, the power of the study was inadequate for a statistically valid estimation of the rate of the rare, severe, intraoperative complications affecting cataract surgery. Only a large multicenter study would provide definitive evidence on this subject.

Probably, the combination of modern phacoemulsification techniques and devices was a key to deliver safe lens surgery in our series, and our experience may be useful to surgeons and patients at the time of preoperative counselling. Hopefully, further reports may confirm the absence of higher-than-average rates of severe intraoperative complications in cases performed by high-volume surgeons.

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