



Approach to Cataract Surgery in the Small Eyes: A Survey of UK Ophthalmologists

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Abstract

Purpose: To survey the differences in clinical and surgical practices in approaching cataract surgery in small eyes amongst ophthalmologists in the United Kingdom.

Setting: The survey was filled out by ophthalmologists practising both in national health services and the private sector.

Design: A prospective cross-sectional survey-based study was conducted between Jan 2022 and Feb 2022.

Methods: The survey questionnaire consisted of 18 multiple-choice questions via SurveyMonkey Inc. based on an extensive literature review and expert opinions available on this topic.

Results: A total of 157 responses were collected through a national survey from Ophthalmic surgeons with varying degree of experience. Thirty per cent of surgeons aim to look for systemic associations associated with small eyes before approaching cataract surgery. A small eye is considered as having an axial length (AL) of less than 22 mm by the majority of participating Ophthalmic surgeons. Half of the participants use pre-operative intra-ocular pressure (IOP) lowering agents i.e. intravenous mannitol or acetazolamide. Forty per cent of experienced surgeons opt for post-operative cycloplegia routinely with one-fourth of this group performing sclerotomies intra-operatively.

Synopsis: The authors present the opinions of a large group of British ophthalmic surgeons dealing with small eye cataract surgery. There does not appear to be a consensus or standardised approach.

Research Ethics Approval: The National Health Services Research ethics committee review suggested that ethics approval is deemed not necessary.

Keywords: Cataract Surgery; Barrett True Axial Length (BTAL); Emmetropia Verifying Optical (EVO)

Introduction

Cataract surgery in small eyes is challenging [1]. Appropriate classification, pre-operative risk stratification, intraoperative surgical techniques and post-operative management all contribute to success of surgery.² These eyes require careful evaluation for pre-existing uveal effusion. Intra-operatively careful creation of wounds of appropriate tunnel length, suboptimal pupillary dilation, anterior chamber space constraints, increased risk of iris prolapse, positive vitreous pressure, risk of peripheral extension of the capsulorhexis and risk of aqueous misdirection all need to be on the radar [1].

Materials and Methods

A cross-sectional survey-based study was conducted by the British Pakistani Ophthalmic Society (BPOS) between January 2022 and February 2022. The study protocol was approved by a BPOS committee. A link to the questionnaire (Table 1) was circulated to ophthalmologists working across the UK via the WhatsApp encrypted messaging platform (WhatsApp Inc, CA, USA). The survey was carried out as a service improvement exercise, there is no patient identifiable data and all data is anonymised. No personal information was acquired from survey participants and all survey data was handled in a confidential manner and therefore The National Health Services Research ethics committee review suggested that ethics approval is deemed not necessary. An 18-item survey was designed following a literature review and various observations of clinical practice amongst expert BPOS members in the UK. Questions were devised to ascertain national clinical perceptions and various clinical approaches while performing cataract surgery in small eyes. RZ designed the initial version of the survey, and this was subsequently revised through three iterations by IM. The survey employed multiple-choice questions with either single or multi-select options. An 'other' option was provided where appropriate and respondents were allowed to elaborate on these answers. Out of 239 members, a total of 157 responses were collected. The completion rate was 100% amongst the 157 respondents. The typical time spent to complete the survey was 2 minutes and 24 seconds.

Results

A total of 157 respondents completed the questionnaire. Over 80% of the respondents were experienced surgeons (defined as

having completed more than 1000 cataract procedures as independent or primary surgeon). Most surgeons identified as working in NHS public sector hospitals, with just over a third operating at multiple venues including independent private sector health care facilities.

Surgeon knowledge of small eyes and associated pitfalls

Respondents were asked how they defined a small eye based on axial length (AL). Amongst experienced surgeons, 30.5% and 28.0% defined a small eye as AL <22 mm and <21 mm respectively. 40% indicated that an AL <20 mm or an abnormal anterior/posterior segment size constituted a small eye. The majority of inexperienced surgeons defined small eyes as having an AL <22 mm.

Majority of surgeons in both groups did not consider Relative Anterior Microphthalmos (RAM) in eyes with normal axial length prior to surgery. Only 30% of surgeons sought to perform any investigations to rule out any systemic associations.

In response to the impact of end-tidal CO₂ (ETCO₂) on choroidal volume and its impact on small eye cataract surgery, 65.6% in the experienced surgeons' group and 86.21% in the inexperienced surgeons' group reported that they were unaware of the impact of ETCO₂. The majority of respondents in both groups reported that they did not measure the choroidal, scleral or choroidoscleral thickness routinely.

Surgeons' pre-operative preparation

The use of systemic IOP-lowering medication preoperatively in the absence of glaucoma was explored. Just over 50% of surgeons in both groups reported that they did not use any systemic medication. The remainder indicated the use of either systemic acetazolamide or intravenous mannitol.

Post-operative cycloplegic use

A follow-up question concerning the use of cycloplegics pre and post-operatively to prevent aqueous misdirection highlighted another interesting variation. The majority of surgeons in both groups did not routinely use any cycloplegics with only 40% of the experienced surgeons and 31% of the inexperienced surgeons reporting use of cycloplegics.

A further question relating to the prevention of post-operative choroidal effusion, especially in high-risk cases was included in this questionnaire. 88.2% of the experienced surgeons indicated that they would not routinely perform sclerotomies in small eyes.

Location and axis of the incision

The location and axis of the incision are paramount in cataract surgery. There is now a growing trend of performing on axis incision to reduce post-operative astigmatism. It was noted in our survey that 74.0% of the experienced surgeons and 76.0% in the inexperienced surgeons group preferred to perform corneal incisions, whereas the remainder performed limbal incisions.

Interestingly, the survey showed that only 33.6% of experienced surgeons offer on on-axis incision compared to 41.3% of inexperienced surgeons.

Only 34.5% of the experienced surgeons group secured the main wound with a suture compared to 41.4% of the inexperienced surgeons.

Selection of intraocular lens

Three questions were included around the selection of intraocular lenses (IOL) in this survey to establish the trend of type of IOL used in small eyes. In the experienced surgeons' group, 62.5% said they used third-generation formulas, 25.0% used fourth-generation and 23.4% used an average of two or more formulas. A small proportion indicated they use Ray tracing or artificial intelligence (AI) based formulas. A similar trend was found amongst the inexperienced surgeons; 51.72%, 21.0% and 31.0% used third-generation, fourth-generation and an average of two or more formulas, respectively. None of the surgeons in this group used Ray tracing or AI-based formulas.

A follow-up question was asked outlining different formulas for eyes with an AL < 22 mm. Amongst experienced surgeons 68.0% and 16.4% use Hoffer Q and Barrett universal II respectively. Up to 6.0% use SRK-T and the Haigis formula. A small proportion of surgeons use Kane, Hill RBF and Holliday 2. When compared with inexperienced surgeons 86.2% use Hoffer Q, 10.3% use Barrett universal II and 3.5% use Holliday 2.

The last question in this subset was designed to ascertain what the surgeons' preference in eyes is where the predicted IOL power was more than 40 dioptres (D). 51.2% in the experienced surgeons group stated they ordered a custom-made IOL, whereas 44.8% stated they used the highest power available and left the patient mildly hypermetropic. Only 4% used a piggyback IOL strategy.

Use of anti-inflammatory medication pre or post-operatively

The majority of the respondents in both groups stated that they did not routinely use intravenous methylprednisolone with only 11.7% and 10.3% in the experienced surgeons and inexperienced surgeons' doing so.

Over 60% in both groups preferred dexamethasone 0.1% eye drops post operatively. Over 30% in both groups preferred prednisolone 1% eye drops postoperatively.

Furthermore, 84.4% in the experienced surgeons' group and 86.21% in the inexperienced surgeons' group prescribed post-operative steroid drops for 4-6 weeks whilst the rest did so for more than 6 weeks.

Discussion

Small eyes (AL < 21 mm) make up 1.4% of the total cataract surgery performed in the United Kingdom.³ Surgery in such eyes can be associated with structural abnormalities which can increase risk of intraoperative complications. The diagnosis and management of these conditions can be challenging in a busy day to day ophthalmology practice. These challenges lead to a higher risk of postoperative complications and more vigilant follow-up is needed [2]. The Royal College of Ophthalmologists' National Ophthalmology Database (RCOphth NOD) study of cataract surgery found that the posterior capsular rupture rate is 1.9 times higher in patients with AL of < 20 mm [4]. Moreover, a recent report by RCOphth NOD stated an overall intraoperative complication rate of 4.5%, 2.9% and 3.3% ($p < 0.001$) for short eyes (AL < 21 mm), medium eyes (AL 21-28 mm) and long eyes (> 28 mm) respectively [3]. The largest study on cataract surgery in small eyes was conducted by Day, *et al.* who found that the short axial length (AL) and reduced anterior chamber depth (ACD) as risk factors for increased rates of complications [5].

The term microphthalmos is used to describe eyes with a shorter AL and is divided into simple and complex depending on the presence of anatomical malformations [6]. Simple microphthalmos is described as 2 standard deviations below the population age-adjusted mean which usually is an axial length <21 mm in adult eyes according to epidemiological studies but historically axial length <20.5 mm has been considered as microphthalmos [7]. Complex microphthalmos is also described as 2 standard deviations below the population mean but these eyes have associated structural abnormalities including uveal colobomas, retinal dysplasia and persistent foetal vasculature [6].

Relative Anterior Microphthalmos (RAM) is an eye where the axial length can be relatively normal but the anterior segment is smaller compared to the posterior segment. It is described differently by various authors. Auffarth, *et al.* have defined relative anterior microphthalmos having horizontal corneal diameter of <11 mm, total axial length (TAL) >20 mm, and an AC depth of around 2 mm [8]. Jong, *et al.* have defined it as an axial length greater than 20.5mm but ACD is 2.2mm or less with a corneal diameter smaller than 11 mm [9].

Nanophthalmos is a rare entity, where the eye has a small anterior segment and increased scleral and choroidal thickness. There is no consensus on the axial length (AL) for nanophthalmic eyes and different authors have different criteria for defining nanophthalmos. However, most authors agree on AL of nanophthalmic eyes to be less than 20.5 mm [10]. In comparison, simple microphthalmos, complex microphthalmos and RAM have normal scleral thickness.

Our survey highlights a great variation in defining the small eyes and we noted a lack of considerate approach to these eyes including RAM. Moreover, the majority of surgeons are not aware of the impact of ETCO₂ on choroidal volume. The effect of ETCO₂ on choroidal volume has been explored both in animals and humans' studies. J. R. Saniuel, *et al.* investigated the effect of ETCO₂ on intraocular pressure (IOP) in patients who underwent general anaesthesia. The study found that the lower the ETCO₂ the lower the IOP and vice versa. This effect could be either be due to vasoconstriction of choroidal blood vessels or reduced aqueous formation [11]. Ozcimen, *et al.* used spectral domain optical coherence tomography (SD-OCT) to measure choroidal thickness in partici-

pants during hyperventilation and found that there is a significant reduction in choroidal thickness during hyperventilation. This effect is due to an increase in the vascular resistance of the vessels and a decrease in ocular blood flow [12].

The use of systemic of mannitol [13] and acetazolamide [14] to reduce IOP pre or post operatively is a common practice worldwide in patients who are at risk of high IOP. Due to structural abnormality that can be associated with these small eyes, managing IOP becomes even more paramount. This survey indicates that more than half of the surgeons do not use any drug to reduce IOP. We believe that the ability to control IOP intraoperatively could be of value in these small eyes as this would reduce positive vitreous pressure and therefore increase the anterior chamber depth. Some surgeons would advocate performing pars plana vitreous tap intraoperatively to expand anterior chamber. However smaller AL and crowded anterior chamber would make this approach very challenging.

The incidence of aqueous misdirection has been reported between 0.4% to 6% in short eyes that underwent cataract surgery with acute angle closure glaucoma which usually co-exists with nanophthalmic eyes [15]. Although there is no consensus on the AL for nanophthalmic eyes, these eyes have short ACD, convex iris configuration and increased choroidal and scleral thickness. Whilst the exact mechanism remains unknown, an increase in choroidal and scleral thickness can be an important risk factor leading to aqueous misdirection. In our survey more than half of the surgeons reported that they do not use cycloplegics on a routine basis and the vast majority do not perform prophylactic sclerotomy.

The incidence of uveal effusion in nanophthalmic eyes ranges from 3.2% to 50% [16,17]. Rajendrababu, *et al.* looked at the safety and efficacy of cataract surgery with and without simultaneous prophylactic posterior sclerotomy to prevent uveal effusion in nanophthalmic eyes. They found that the overall complication risks were reduced by 50% in eyes who underwent prophylactic sclerotomy. Furthermore, uveal effusion was far less common in sclerostomy group [18]. The scleral window can serve as an outflow pathway for the suprachoroidal fluid that may be accumulated during or after cataract surgery.

On axis incision to reduce corneal astigmatism is desirable. However, surgeons should be mindful of increased risk of compli-

cations associated with cataract surgery in small eyes. Since most patients will have against the rule astigmatism, the temporal approach may not be the most convenient position for most surgeons which will make the surgery more difficult in an already challenging case. Interestingly, in our survey, a higher number of inexperienced surgeons operate on axis when compared to the experience group which we believe may highlight the lack of awareness.

Over the years we have seen an improvement in IOL calculations as the newer generation formulas use multiple variables in addition to AL and Keratometry readings. The most recent guideline published by The Royal College of Ophthalmologists recommends the use of either Hoffer Q or Haigis in patients with AL<22mm [19]. Our survey reflects similar practices where the majority of the surgeons in both groups use third generation formulas for patients with small eyes. There is now a growing trend towards the use of these newer generation formulas and numerous reports have been published showing their accuracy. Shamma, *et al.* analysed the accuracy of these newer formulas and compared them with Haigis, Hoffer Q, Holladay 1 and SRK/T formula. They reported the lowest mean absolute error (MAE) for Barrett True Axial Length (BTAL), Emmetropia Verifying Optical (EVO), K6, Olsen, and Prediction Enhanced by Artificial intelligence and output Linearization – Debellemanni, Gatine, Saad (PEARL-DGS) in the short eye [20]. Furthermore Darcy and colleagues performed a retrospective review of over 13000 routine cataract surgeries between May 2008 and November 2017 and found that Hill 2.0, Olsen, Holladay 2-AL adjusted and Barrett have the lowest MAE when compared to third generation formula. In eyes with AL <22.0 mm Kane has the lowest MAE which was statically significant [21].

Small eyes are usually more prone to postoperative anterior chamber inflammation. However, they do respond well to topical corticosteroids. Day, *et al.* reported severe postoperative inflammation in 4 out of 103 nanophthalmic eyes that responded well to intense topical steroids [22]. Another study looked at 84 RAM patients and reported 12% with grade 3 flare and cells by Hogans criteria. These eyes were given additional Ketoralac tromethamine 0.5% which resolved the inflammation within 2 weeks [23].

In summary, good refractive outcomes after cataract surgery are regarded as a quality benchmark [24]. It is recognized that small eyes require careful selection of appropriate biometric formulae and the use of inappropriate formulae can result in sub-optimal visual outcomes [25]. However, predicting a good refractive outcome in small eyes may be more challenging due to increased post-operative astigmatism secondary to shorter WTW, difficulty in predicting the effective lens position and lack of stringent industrial standards in IOL powers over +30D. Moreover, these eyes require careful surgical planning to minimize intraoperative and postoperative complications.

This study highlights the attitudes and practices of cataract surgeons in their approach to the unique challenges of cataract surgery in small eyes. Recommendations from the Royal College of Ophthalmologists would be welcomed to try and identify potential improvements.

What was known

- Cataract surgery in small eyes is very challenging and carries a high risk of intra-operative and post-operative complications.

What this paper adds

- This study demonstrates the lack of standardised approach taken by ophthalmic surgeons when dealing with cataract surgery in small eyes in the United Kingdom.

Conflict of Interest

The authors declare no conflict of interest. No funds have been received for this work.

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