Outcomes of phacoemulsification and intraocular lens implantation in microphthalmos and nanophthalmos

Alexander C. Day, MB BS, BSc, MRCOphth, Robert E. MacLaren, DPHil, FRCS, FRCOphth, Catey Bunce, DSc, Julian D. Stevens, FRCOphth, Paul J. Foster, PhD

PURPOSE: To evaluate the outcomes of phacoemulsification and intraocular lens (IOL) implantation in microphthalmos and nanophthalmos.

SETTING: Moorfields Eye Hospital, London, United Kingdom.

DESIGN: Retrospective case series.

METHODS: Eyes with an axial length (AL) less than 21.0 mm had elective phacoemulsification and IOL implantation.

RESULTS: One hundred three eyes (63 patients) were enrolled. The median AL was 20.65 mm (interquartile range [IQR], 20.26 to 20.86) and the median follow-up, 6.3 months. Complications occurred in 16 cases (15.5%). Zonular dehiscence, severe uveitis, and aqueous misdirection accounted for the majority of complications. Complication rates were 6 (7.3%) of 82 cases with an AL from 20.0 to 21.00 mm and 10 (47.6%) of 21 cases with an AL less than 20.0 mm ($P=.0001$). Only AL (odds ratio [OR], 0.52 per mm; $P\leq.0005$) and abnormal intraocular pressure (IOP) of 22 mm Hg or more or on topical IOP control (OR, 10.1; $P=.001$) were significant independent risk factors for complications. For the cohort after adjusting for abnormal IOP, an AL less than 20.5 mm was associated with a 4 times higher odds of any complication ($P=.028$), an AL less than 20.0 mm was associated with a 15 times higher odds of any complication ($P\leq.0005$), and an AL less than 19.00 mm was associated with a 21 times higher odds of any complication ($P\leq.0005$).

CONCLUSIONS: Phacoemulsification and IOL implantation in microphthalmos/nanophthalmos was challenging but appears safer than previously reported. A shorter AL and abnormal IOP were significant risk factors for complications.

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Microphthalmos and nanophthalmos describe an eye that is smaller than normal and are subdivided into those that are morphologically normal (pure microphthalmos) or, more commonly, associated with other ocular anomalies (complex microphthalmos).[1] The classic definition by Duke-Elder[1] of a nanophthalmic eye is one having about two thirds the normal volume with a typical axial length (AL) of 16.0 mm to 18.5 mm with marked hyperopia, late-onset glaucoma, and occasional macular hypoplasia. Today, microphthalmos and nanophthalmos are used interchangeably and cases are defined primarily by short ALs with values of less than 21.0 mm,[2,3] less than 20.5 mm,[4–8] less than 20.0 mm,[6,9–11] less than 18.0 mm,[12,13] or less than 17.0 mm.[14] Both autosomal dominant and recessive inheritance patterns have been reported[15,16] and have been mapped to various different chromosomal regions and monogenic causes.[17]

Patients with nanophthalmos are at high risk for developing angle-closure glaucoma (ACG).[1,8,12,15] When this occurs, it is difficult to manage because the response to conventional medical treatment is variable[6] or poor,[2–4] with miotics often increasing pupillary block. Laser peripheral iridotomy and iridoplasty may be of benefit[6] but usually do not control the intraocular pressure (IOP) sufficiently.[18] Surgical

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procedures for glaucoma are not recommended or must be performed early[4–7,19] because of the high risk for complications.[6,9–11] Singh et al.[6] report that "nanophthalmic eyes respond disastrously to intraocular surgery"; however, they observed that lens removal in nanophthalmos "relieves the anterior chamber crowding resulting from lens thickening, and, theoretically could be considered as an option for prophylaxis" if it were not for the high rate of complications associated with lens surgery. In 2000, Auffarth et al.[8] suggested this statement was no longer accurate for patients with nanophthalmos because of advances in cataract surgery. Since then, lens-surgery techniques have been further refined and phacoemulsification is increasingly being performed for the correction of hyperopia and in the contemporary management of primary angle closure[20] or primary angle-closure glaucoma (PACG)[20] in addition to cataract. Despite this, subsequent reports of lens surgery in nanophthalmos have been limited to single case reports or small case series. Based on this and the heterogeneity in case definitions, we reviewed the results of all phacoemulsification lens surgery procedures in patients with nanophthalmos performed by 2 surgeons (J.D.S., P.J.F) who have significant experience in managing these cases. We specifically evaluated whether complications were associated with an abnormal IOP preoperatively.

PATIENTS AND METHODS

All elective phacoemulsification and intraocular lens (IOL) implantation cases performed in patients with microphthalmos/nanophthalmos were identified from 2 personal surgical outcomes databases. Microphthalmos/nanophthalmos was defined as a small, but morphologically normal, eye with an AL at least 2.0 standard deviation (SD) below the population mean (ie, <21.00 mm).[21] Approval for data access was given by the Clinical Audit Department, Moorfields Research and Development.

Axial length, anterior chamber depth (ACD) (defined as corneal epithelium to anterior crystalline lens surface), and corneal keratometry were measured in all cases using an IOLMaster (Carl Zeiss Meditec AG). Lens and scleral thicknesses (when performed) were measured by ultrasound. Intraocular pressure was measured by Goldmann applanation tonometry (GAT) or by biomechanical waveform analysis (Ocular Response Analyzer, Reichert, Inc.) using the mean of 3 Goldmann-correlated IOP values. An abnormal IOP was defined as 22 mm Hg or higher or requiring treatment to maintain an IOP below this. All cases were performed with a 2.75 mm clear corneal incision and phacoemulsification using a Whitestar Signature phacoemulsification system (Abbott Medical Optics) or an Infinity or Legacy phacoemulsification system (Alcon Laboratories, Inc.) with IOL implantation in the capsular bag. Preoperative and postoperative corrected distance visual acuity (CDVA) was measured in all cases by Snellen charts and converted into logMAR for analysis. All intraoperative and postoperative complications and subsequent laser or surgical procedures performed were identified by detailed review of surgical databases and patients' medical records. An intraoperative complication was defined as any issue requiring a deviation from the standard surgical method or recorded observation made during surgery. A postoperative complication was defined as any postoperative issue requiring intervention (medical, laser, or surgical) with the exception of neodymium:YAG (Nd:YAG) capsulotomy for posterior capsule opacification (PCO) or refractive laser surgery for residual ametropia.

Indications for surgery were correction of hyperopia, cataract, and the management of angle closure with abnormal IOP (>21 mm Hg or requiring topical glaucoma treatment). As cases were usually performed for more than 1 indication, analysis was performed based on the presence or absence of an abnormal IOP. For patients who had bilateral procedures, if the IOP was abnormal in 1 eye, this indication was assumed to be true for the contralateral eye in all instances.

Data were managed using Excel software (Microsoft Corp.), and statistical analysis was performed using SPSS software (version 20, SPSS, Inc.) or Graphpad Prism software (version 5, Graphpad software, Inc.). Testing of normality was performed by Kolmogorov-Smirnov and Shapiro-Wilk tests. If data were not normally distributed, medians with 25% and 75% interquartile ranges (IQR) are reported in addition to the mean and SD. The Fisher exact test was used for analyzing 2 × 2 contingency tables. Linkage between eyes was evaluated using the McNemar test. Univariate and multiple variable logistic regressions were performed to estimate the odds ratio (OR) for each variable with optimum adjustment for possible confounding effects of all other variables included in the regression model. All predictors were considered for inclusion in multivariate models. Multiple variable models were determined by a backward-selection technique; variables were included in the final model only if significant ($P \leq .05$).

RESULTS

One hundred three eyes of 63 patients (16 men, 47 women) with an AL less than 21.0 mm had

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Corresponding author: Alexander C. Day, MB BS, BSc, MRCOphth, UCL Institute of Ophthalmology, 11-43 Bath Street, London, EC1V 9EL, United Kingdom. E-mail: alex.day@ucl.ac.uk.