

GLAUCOMA MANAGEMENT IN NANOPHTHALMOS



Small eyes can present big challenges.

BY MOHAMMAD PAKRAVAN, MD

Nanophthalmos is an uncommon developmental ocular disorder characterized by a structurally normal but smaller eye. Management of patients with nanophthalmic eyes can pose significant challenges because of the inherent characteristics of these eyes, such as high hyperopia, short axial length, and structural abnormalities of the sclera, which can lead to serious intraoperative and postoperative complications.

TERMINOLOGY

The clinical spectrum of small-eye disorders includes conditions in which there is overall shortening of the eye, as in *nanophthalmos*, and shortening in combination with other ocular anomalies, as in *microphthalmos*. Sometimes either the anterior segment (*relative anterior microphthalmos*) or posterior segment (*relative posterior microphthalmos*) of the eye is undersized.¹ Microphthalmos is described as an axial length of at least two standard deviations below the average for the patient's age.² It is categorized as simple (nanophthalmos) or, when accompanied by other ocular abnormalities, complex.²

Nanophthalmos stems from the Greek word *nano*, meaning dwarf. This condition is a subtype of microphthalmos and may appear isolated or as part of a syndrome along with retinitis pigmentosa, optic disc drusen, or autosomal-dominant vitreoretinopathy.³⁻⁵

PATHOPHYSIOLOGY AND GENETICS

Nanophthalmic eyes have anomalous collagen fibers in all three layers of

the sclera. The combination of high hyperopia, abnormal scleral fibers, and increased scleral thickness is responsible for secondary complications, including angle-closure glaucoma, scleral inelasticity, compression of vortex veins, uveal effusion, and retinal detachment.⁶

Nanophthalmos occurs due to arrested development of the eye in the early stages of embryogenesis. It can occur either as a sporadic condition or as a familial disorder with autosomal-dominant or recessive transmission. Sporadic forms may be caused by environmental factors or new mutations that result in the arrest of ocular growth.⁷ To date, five genes and two loci have been reported to be associated with familial nanophthalmos. *NNOS2* is connected to mutations in the membrane frizzled-related protein, or MFRP, gene. This gene appears to have a central function in ocular development as a regulator of ocular dimension.^{7,8}

CLINICAL FEATURES

Eyes with simple nanophthalmos have no apparent ocular abnormalities besides their small size. Nanophthalmos typically presents as a small and highly hyperopic eye set deeply into the orbit. Hyperopia may range from +8.00 D to more than +25.00 D sphere.⁹ Widely different criteria for the diagnosis of nanophthalmos have been proposed, including high hyperopia, shallow anterior chamber, high ratio of lens-to-eye volume, posterior wall thickening of more than 1.7 mm, and axial length of 21.0 mm or less.¹⁰

In nanophthalmos, corneal diameter ranges from 9.0 mm to 11.5 mm, with

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topographically high curvature with or without astigmatism. Fundus examination may be normal or may reveal a crowded disc, disc drusen, macular hypoplasia, rudimentary foveal avascular zone, or a variety of peripheral retinal findings.¹¹ On indirect ophthalmoscopy, retinal vessels and the optic disc may be visible even without a magnifying lens. OCT findings include absence of the foveal pit, macular thickening, schisis, foveal cyst, and retinal folds.^{11,12}

In nanophthalmic eyes, visual acuity is rarely better than 20/40 and is generally affected by high refractive error and amblyopia in childhood. Visual acuity may also be affected by secondary complications, such as angle-closure glaucoma, exudative retinal detachment, or abnormal foveal avascular zone.¹¹ Additionally, nystagmus and strabismus (typically esotropia) may be observed.

A high ratio of lens-to-eye volume may result in a shallow anterior chamber, high iris convexity, and a narrow or closed angle with peripheral anterior synechiae (PAS).¹³

DIAGNOSIS

Because of the small disc, even a small cup-to-disc ratio could be attributed to glaucoma. Because of high hyperopia, thick corrective lenses and amblyopia affect visual field results and limit its

usefulness in diagnosis and follow-up of these cases. Spectral-domain OCT (SD-OCT) that can detect subtle nerve fiber layer loss and fundus photography are useful and reliable measures for follow-up.¹⁴ Anterior segment OCT studies in nanophthalmic eyes have shown lower anterior chamber parameters.¹⁵ Ultrasound biomicroscopy could also be helpful to find angle parameters as well as subtle and subclinical effusions.

GENERAL MANAGEMENT

Nanophthalmos presents several challenges for clinicians, and early diagnosis and management are vital. Refractive errors should be fully corrected with spectacles, bifocals, or contact lenses. This is especially important in children to prevent amblyopia and strabismus. In children with amblyopia, patching is preferable to penalization with atropine. Strabismus surgery may be required in some cases of esotropia and amblyopia if the patient is not responsive to other measures.

Due to recent advances in technique and the high safety profile of phacoemulsification, it is suggested that cataract surgery be performed before a glaucoma operation. Phacoemulsification may address and eliminate some of the main culprits of glaucoma in nanophthalmic eyes, including the lens and narrow angle,¹⁶ although appropriate IOL power measurement must be performed and the choice of IOL must be determined. Nevertheless, piggyback IOL implantation should be avoided because of the high risk of secondary pigment dispersion, angle narrowing, and interlenticular cellular growth and opacification.¹⁷

To improve cataract surgery results, medical dehydration of the vitreous, sclerectomy, scleral lamellar resection, and even partial core vitrectomy have been suggested. Nonetheless, due to the short eye and ocular comorbidities, sudden decompression after surgery may cause choroidal effusion and consequent suprachoroidal hemorrhage, retinal detachment, vitreous loss, intraocular hemorrhage, and even phthisis.¹⁰

MANAGEMENT IN GLAUCOMATOUS EYES

Medical. When IOP is high, medical treatment should be tried before any intraocular intervention, although the rate of failure of medical treatment is considerably high.

Laser. Laser options used to prevent or treat angle-closure glaucoma include Nd:YAG laser peripheral iridotomy (LPI) and argon laser peripheral iridoplasty. In eyes with occludable angles and normal IOP, LPI should be performed to prevent PAS formation. However, this does not eliminate the risk of PAS, and argon laser peripheral iridoplasty may be the next option.

Surgical. With the improvement of cataract surgery techniques, phacoemulsification with IOL implantation is the first intraocular procedure usually recommended. After the completion of cataract surgery, gonioscopy can help detect PAS. Goniosynechialysis may also be added. Some surgeons suggest combining endoscopic cyclophotocoagulation with cataract surgery as well. Because of the high complication rate of trabeculectomy in small eyes,¹⁸ glaucoma drainage device with complete tube ligation could be the next option if the glaucoma is not controlled after cataract surgery. Diode cyclophotocoagulation could also be considered, especially in advanced and higher risk cases.

Malignant glaucoma is a prevalent complication that may occur after surgery in these eyes (Editor's note: For more on malignant glaucoma, see page 29). This complication requires a step-wise approach that includes medical and laser treatment comprising Nd:YAG laser posterior capsulotomy and anterior hyaloidotomy, potentially followed by pars plana vitrectomy or mini-vitrectomy.¹⁹

CONCLUSION

Nanophthalmos has a wide clinical spectrum, affecting eyes with axial lengths from 12 mm to 21 mm, and the shorter the eye, the higher the risk of disease progression and complications. Correction of high refractive errors and

amblyopia therapy should be considered at an early age. Glaucoma, which typically develops in adulthood, requires close monitoring for proper identification and effective management. ■

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