Polskie Towarzystwo Okulistyczne
www.pto.com.pl

CASE REPORT

KLINIKA OCZNA 2021, 123, 3: 145–150
Received: 22.07.2020 Accepted: 10.09.2020

Access this article online
Website: www.klinikaoczna.pl
DOI: https://doi.org/10.5114/ko.2021.110006

Surgical removal of the lens with vitrectomy in patients with nanophthalmos and glaucoma

Anna Kamińska[1,2], Magdalena Sołtysiuk[1], Agnieszka Romaniak[1], Jacek Szaflik[1,2]

[1]Independent Public Clinical Ophthalmological Hospital in Warsaw, Poland
[2]Chair and Department of Ophthalmology, II Faculty of Medicine, Medical University of Warsaw, Poland

ABSTRACT

Nanophthalmos is a rare eye developmental disorder associated with anatomical and ultrastructural abnormalities that predispose to specific comorbidities including secondary angle-closure glaucoma that frequently proves recalcitrant to treatment. These abnormalities might increase the rate of complications associated with intraocular surgery. This paper discusses pathomechanisms that underlie the development of such complications. The outcomes of phacoemulsification combined with pars plana limited vitrectomy are also presented. This surgical modality allows safe and minimally invasive cataract extraction in small eyes with extremely shallow anterior chamber and elevated intraocular pressure. The benefit is not only vision improvement, but also glaucoma treatment due to elimination of anatomical conditions that contribute to angle closure. This may require extraction of a clear lens.

KEY WORDS: glaucoma, cataract, phacoemulsification, vitrectomy, nanophthalmos.

INTRODUCTION

In 1982, Omah S. Singh published the results of intracapsular lens extraction surgery in patients with nanophthalmos. Based on his findings, he recommended that surgical treatment should be delayed as long as possible because of its disastrous effects on vision [1].

Advances in ophthalmic microsurgery have contributed to increasing the safety of surgical procedures in patients with nanophthalmos. Nonetheless, potentially vision-threatening complications are more common in this group of patients than in the general population.

In this paper, we present the effects of employing a surgical technique that combines cataract phacoemulsification with excision of the anterior vitreous via the pars plana. This procedure allows for safe lens extraction and IOL implantation in patients at particularly significant risk for intraoperative complications.

NANOPHTHALMOS

The Greek term nanophthalmos (nanos = dwarf) describes a disorder characterized by a small eye (less than 2 standard deviations for the age norm) without any associated malformations [2, 3]. It is a condition in the spectrum of microphthalmia resulting from abnormalities in the development of the organ of vision. Nanophthalmos is a rare disorder which typically has no genetic background, though there are known cases with an established pattern of inheritance.

The anatomical and ultrastructural alterations associated with the condition predispose patients to the development of certain disorders as well as an increased number of complications during intraocular surgical procedures potentially leading to vision loss [4-6]. In order to adequately monitor and treat patients with this rare developmental disorder of the eye, it is important to be thoroughly familiar with its clinical presentation.

CLINICAL PICTURE AND PATHOPHYSIOLOGY OF DISORDERS ACCOMPANYING NANOPHTHALMOS

The clinical presentation of nanophthalmos consists of narrow palpebral fissures with a small eyeball deeply set in the orbit [4]. In adult patients with nanophthalmos, the axis of the eye does not exceed 21 mm in length [2, 3]. Depending on the curvature of the cornea and the coexistence of other pathologies (e.g. microcornea), different levels of hyperopia (even above 25D) are observed. Failure to correct the refractive defect early can result in low vision, amblyopia and strabismus [5].

CORRESPONDING AUTHOR
Magdalena Sołtysiuk, MD, Independent Public Clinical Ophthalmological Hospital, 13 Sierakowskiego St., 03-709 Warsaw, Poland, e-mail: soltysiukmagdalena@gmail.com

The dimensions of the lens in nanophthalmic eyes are the same as in the healthy population, which, combined with a reduced eye volume, results in crowding of intraocular structures, including a shallow anterior chamber with a forward displacement of the lens–iris diaphragm. With the deposition of new lenticular fibers, the imbalance increases, leading to appositional angle closure with a pupillary block that is unresponsive to miotics. Laser iridotomy to unblock the filtration angle may turn out to be ineffective. Close iridocorneal contact contributes to the formation of anterior adhesions [6]. In patients with nanophthalmos, closed-angle glaucoma occurs in the 3rd or 4th decade of life, with an incidence reaching up to 66.7% of patients [7, 8]. A very small optic disc makes it difficult to identify glaucomatous changes by ophthalmoscopy, and intraocular pressure control is rarely achieved with conservative management [6]. For these reasons, patients with nanophthalmos may benefit from lens extraction, even if the lens is clear [9-11].

In nanophthalmic eyes, the sclera is thickened, with reduced elasticity, which may impair the outflow of blood through the vortex veins. Impaired circulation in the choroid causing choroidal hyperemia leads to the formation of exudates with fluid sequestration and choroidal separation that can result in serous retinal detachment [12]. These complications may occur spontaneously, but also during laser therapy or intraocular surgical procedures due to a sudden drop in intraocular pressure [6, 13]. It has been hypothesized that differences in the physicochemical properties of the sclera are attributable, among other factors, to changes in the structure and arrangement of collagen fibers and abnormalities relating to proteoglycans, i.e. molecules which regulate, for example, water binding in the tissue [12, 14].

All the above-described factors place patients with nanophthalmos in the high-risk group for developing malignant glaucoma. Even though numerous conservative and surgical treatments have been reported, because of the recurrent nature of the disease and failure to achieve long-term intraocular pressure control, malignant glaucoma in this group of patients is associated with a high risk of optic nerve damage and loss of vision. This is why the condition was historically termed "malignant" by Graefe in 1869 [15, 16].

SAFETY AND OUTCOMES OF CATARACT SURGERY IN PATIENTS WITH NANOPHTHALMOS

The actual complication rate of cataract surgery in patients with nanophthalmos is difficult to estimate. Most of the data available in the literature come from retrospective analyses of small case series with heterogeneous patient groups. The overall rate of complications associated with phacoemulsification reported over the last decade ranges from 10% to 27.9%, which is higher than published values for the general population [3, 17-21]. In the largest retrospective analysis by Day *et al.*, including 103 eyes with an axial length < 21 mm, the complication rate was found to be 15.5%. The risk of complications was higher in patients with shorter axial length (4-fold for AL ≤ 20.5 mm, 15-fold for AL < 20 mm, and 21-fold for AL < 19 mm in different study cohorts, respectively). Axial length was also shown to be a significant independent risk factor for complications ($p \leq 0.0005$) [3].

Advances in surgical techniques have contributed to improving the safety of cataract surgery in patients with nanophthalmos, so earlier reports suggesting that the procedure is associated with catastrophic effects have essentially lost their relevance. However, nanophthalmic patients are still a high-risk group for complications including intraoperative endothelial damage, iris prolapse and damage, lens capsular rupture with/without vitreous leakage, and suprachoroidal hemorrhage [21]. The complications have their origin in positive vitreous pressure (PVP), which results from a disturbance in the delicate pressure balance between the anterior and posterior segments of the eye. The opening of the anterior chamber and drainage of aqueous humor induce hypotony in the anterior segment and cause displacement of the iris-lens diaphragm and posterior ocular structures towards the front of the eye. This unfavorable pressure difference is additionally exacerbated by choroidal hyperemia associated with nanophthalmos, lower positioning of the patient's head during surgery, conditions that impair venous outflow from the orbit, and external pressure on the sclera (eyelid speculum, instruments, operator's hand, compression of the oculomotor muscles under drip anesthesia or the anesthetic agent and possible hemorrhage under periocular anesthesia). Although this phenomenon is observed in every patient undergoing surgery, it is particularly in nanophthalmic eyes. Since they have a small volume, even the loss of 0.2 ml of aqueous humor may set off a catastrophic string of events [13].

Patients with nanophthalmos are also more likely to experience postoperative cystoid macular edema, malignant glaucoma, exudative choroidal detachment, or retinal separation [6, 21]. Postoperative refractive outcomes prove unsatisfactory as well, which is due to the lack of dedicated calculation formulas, difficulty in determining effective lens position following removal of the native lens, large refractive shifts resulting from axial length measurement errors (even up to 4-5D per 1 mm error at AL< 22 mm), and limited availability of high power IOLs (> 40 D) [6].

FACTORS IMPROVING THE SAFETY OF PHACOEMULSIFICATION

Cataract surgery in patients with nanophthalmos requires the surgeon to be thoroughly familiar with the risk factors for complications which are related to the distinctive structure of nanophthalmic eyes. There are a number of aspects which contribute to improving the safety of phacoemulsification, such as reducing the time of the procedure to the necessary minimum, well thought-out use of surgical instruments without unnecessary manipulations, appropriate wound construction, and skillful application of viscoelastics.

It is currently believed that single-piece foldable IOLs are optimally suited to correcting aphakia in patients with nanophthalmos. Their advantages over three-piece IOLs and rigid IOLs include relatively small thickness and high power (up to +60 D), soft haptics for optimal adaptation to different posterior capsule dimensions, and the fact that they can be implanted through a small corneal incision [22]. Treatment of nanophthalmic patients can be performed using commercially available standard-size IOLs, as the lens in patients with nanophthalmos is – by definition – of normal size [3, 19]. Due care must be taken during the procedure to ensure that the posterior capsule remains intact. If it is damaged, placing an IOL in the ciliary sulcus may cause a crowding effect in the anterior chamber and lead to the development of glaucoma. For this reason, implanting several IOLs (so-called *piggybacking*) or anterior chamber IOLs in patients with nanophthalmos is not currently recommended.

Intrascleral IOL fixation in nanophthalmic eyes carries a high risk of complications due to an extensive opening of the anterior chamber [22]. As a result, in some cases it might be necessary not to undertake IOL implantation because of the risk of complications.

There have been isolated reports on the application of personalized reduced-size IOLs in the treatment of patients with nanophthalmos. They may prove to be particularly beneficial in cases of secondary implantation in patients with coexisting small lens and cornea (< 9 mm in diameter) [23-25].

Preoperative preparation also carries significance, including administration of drugs lowering intraocular pressure and draining the vitreous, as well as personalized anesthesia and individually adjusted patient position. These measures are aimed to reduce excessive pressure in the vitreous chamber which is responsible for the shallowing of the anterior chamber along with its associated adverse effects [13]. In patients with pupillary block or at high risk of angle closure, preoperative laser iridotomy should also be considered.

Occasionally, however, despite pharmacological pre-treatment, the chamber is lost and intraocular structures prolapse during surgery. Extreme shallowing of the anterior chamber with iridocorneal contact may render the surgical procedure non-viable. In such cases, some authors recommend additional decompression of the vitreous chamber through its partial removal.

The techniques described in the literature include vitreous tap (aspiration using a needle mounted on a syringe) and pars plana vitrectomy. The former method, despite being effective, is not suitable for the removal of the vitreous cortex in patients in whom it has not liquefied (e.g. young individuals), which makes it of limited use in a considerable number of nanophthalmic patients [26]. Vitrectomy, on the other hand, has no such limitations.

PARTIAL VITRECTOMY BY PARS PLANA APPROACH IN CATARACT SURGERY

The application of this technique may either precede or follow the opening of the anterior chamber, when it is difficult to maintain chamber stability by viscoelastics and infusions, and when signs of PVP are observed (elevated intraocular pressure, shallowing of the anterior chamber, iris prolapse, bulging of the lens capsule).

Placing a single small caliber port (25/23G) 3.5 mm posterior to the corneal limbus is used for the initial removal of the retrobulbar portion of the vitreous (anterior cortex) using a vitreous cutter, possibly with the anterior limiting membrane (approximately 0.2-0.3 ml), until the anterior chamber is deepened and the desired ocular tension is achieved. In patients with a clear lens, the procedure is done under visual control. If the cataract prevents visualization of the tip of the vitreous cutter, care should be taken not to damage the lens capsule and the ligamentous apparatus of the lens. Leaving the vitrectomy cannula sealed with a valve allows the procedure to be repeated, if necessary.

Benefits of this reduction in vitreous volume are due to posterior displacement of the iris-lens diaphragm, with deepening of the anterior chamber and attenuation of displacing forces acting on the lens capsule. Consequently, it is possible to improve the surgical conditions in the anterior segment of the eye, increasing the working space and enabling proper construction of the incision, thus reducing the risk of prolapse of ocular tissue through the open wound, damage to the endothelium and iris, or intraoperative pupillary constriction. Other benefits include a lower risk of uncontrolled capsulorhexis, damage to the posterior capsule and the ligaments of the lens, and the outflow of the vitreous humor. A deeper anterior chamber is also an important factor determining the success of IOL implantation, as high-power lenses, which are thicker and more rigid, can be particularly problematic in nanophthalmic eyes [10, 27].

Controlled decompression of the posterior segment of the eye, by eliminating abnormal intraocular pressure gradient, also lowers the risk of suprachoroidal hemorrhage [13, 27].

In addition, it has been shown that performing initial vitrectomy reduces the ultrasound energy during phacoemulsification [11]. This procedure enables cataract phacoemulsification and improves the safety of surgery performed under conditions of elevated intraocular pressure and PVP [10, 11, 27]. However, it also carries a small risk of complications typically associated with vitreoretinal surgery (including hypotony, lenticular and retinal damage, intraocular inflammation), hence the need for careful fundus evaluation during the postoperative period [28, 29].

CASE REPORTS

Patient 1

The patient was a 31-year-old woman diagnosed with secondary closed-angle glaucoma, nanophthalmos, severe hyperopia, keratoglobus (in both eyes) and a history of amblyopia (in the right eye). The patient had undergone laser iridotomies in both eyes. During the visit, she reported frequent recurrent headaches. The patient had been permanently treated topically with a combination drug (dorzolamide and timolol) twice daily and latanoprost once daily.

The patient's visual acuity parameters were: Vod = 5/30 cc +15.0 Dsph, Vos = 5/6 cc +12.0 Dsph. Intraocular pressure measured using Goldmann applanation tonometry gave the following values: Tod = 24 mmHg, Tos = 12 mmHg. On slitlamp physical examination, the anterior chamber appeared shallow in the right eye, and moderately deep in the left eye, with peripherally patent laser iridotomies in both eyes. The optic discs were pale pink, C/D 0.5, and the limbus pink in color. Optic disc drusen were found in the left eye. No other abnormalities were noted.

Anterior segment optical coherence tomography (AS-OCT) of the right eye revealed iridotrabecular contact involving 90% of the circumference. (Fig. 1. AS-OCT image of the right eye in Patient 1).

Ultrasound biomicroscopy (UBM) performed in both eyes showed an increased anteroposterior dimension of the lens, anterior rotation of the ciliary processes with prominent abutment of the parabasal portion of the iris, possibly consistent with malignant glaucoma. The filtration angle was slit-like narrow along most of the circumference, closed in places, and only open nasally to 10 degrees.

The biometric parameters of the right eye were: AL 16.28 mm, anterior chamber depth 2.21 mm, lens thickness 4.32 mm.

Because of unfavorable anatomical conditions in a very short eyeball and high risk of complications, the patient was scheduled for combined phacovitrectomy of the right eye with clear lens removal in order to open up the filtration angle and improve the control of intraocular pressure. Before the procedure, the patient was given an intravenous infusion of 250 ml of 20% mannitol.

The surgery was performed under periocular anesthesia. The initial stages of the procedure, following preliminary 23 G posterior vitrectomy, proceeded without complications. While removing the remaining cortical masses, the intraocular pressure increased, which manifested itself in the prolapse of the iris through the ports. Partial removal of the vitreous was performed again, so that further steps of the procedure could be completed safely. An IOL with the highest available power (+40 D) was implanted. According to the calculations, a +45D IOL would have been optimal. After IOL implantation, the patient developed a complication in the form of sectoral hemorrhagic choroidal detachment. During attempts to seal the corneal port, iris prolapse occurred, so the wound was closed with a single suture.

On postoperative day 5, the patient's Vod = 5/25 f cc + 4.0 Dsph, Tod = 18 mmHg while on treatment with three medications (following the same treatment regimen as prior to surgery). The anterior chamber of the eye was shallow in the nasal part, and otherwise it was moderately deep. The pupil was rigid, dilated after atropine application, uneven, with adhesions seen at 2 and 4 o'clock. In addition, a reabsorbing preretinal hemorrhage was noted, along with multiple floaters and blood clots in the vitreous (primarily in the lower part) and local choroidal detachment.

AS-OCT examination of the right eye revealed deepening of the anterior chamber (compared to preoperative measurements), open filtration angle, iridotrabecular contact below 35 degrees, and correct positioning of the IOL (Fig. 2. AS-OCT image in patient 1).

Two months after the procedure, the patient came in for a scheduled follow-up. The values were Vod = 5/20 cc + 4.0 Dsph, Tod = 13 mmHg. The patient used a combined preparation of dorzolamide and timolol twice a day, as well as at-

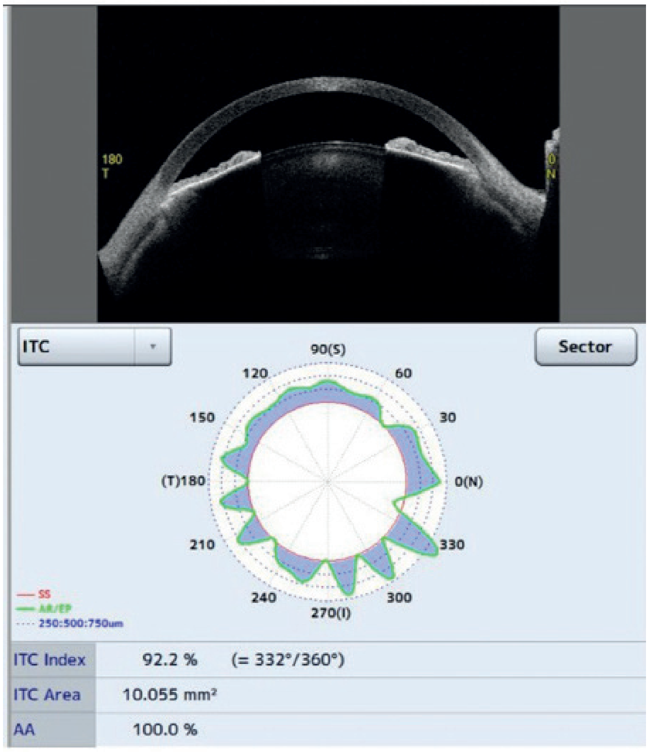

Figure 1. AS-OCT image of the right eye in patient 1

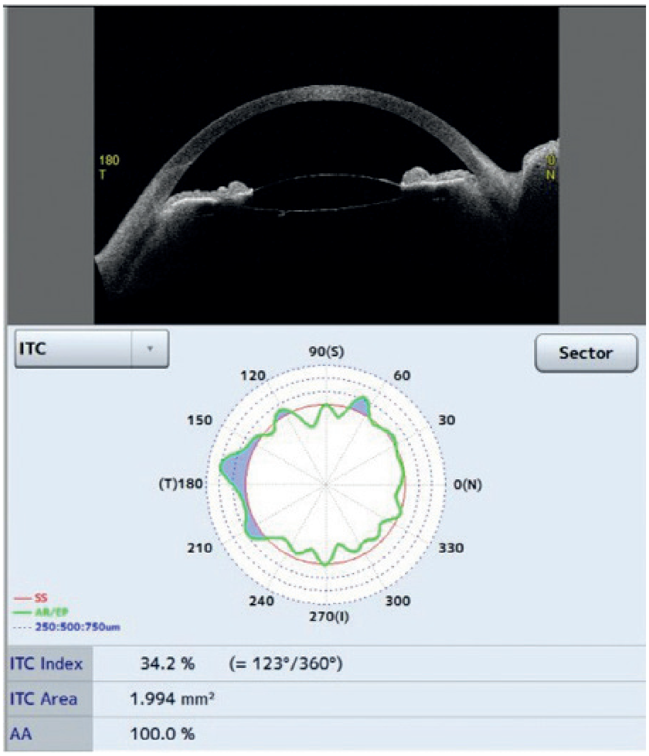

Figure 2. AS-OCT image in patient 1

ropine at tapering doses. Attempts to discontinue the drug completely resulted in the shallowing of the anterior chamber and a rise in intraocular pressure. Ultrasound examination showed no signs of choroidal separation.

The next follow-up evaluation took place three months after the procedure. Seven days before the appointment, atropine was discontinued. On the day of the examination, the anterior chamber of the right eye remained moderately deep, and Tod = 14 mmHg, while on treatment with dorzolamide and timolol. The patient's visual acuity was Vod = 5/25 f cc + 4.0 Dsph. She still remains under the care of the outpatient clinic.

Patient 2

The patient was a 61-year-old woman with closed angle glaucoma in both eyes, absolute glaucoma in the right eye, complicated by cataract in the left eye, and hyperopia. Vod = no sense of light, Tod = 60 mmHg. Vos = 5/7 cc + 5.0 Dsph, Tos = 14 mmHg.

Examination of the left eye revealed anterior adhesions at 12 o'clock, pupil bound by posterior adhesions, and significant shallowing of the anterior chamber. The depression of the optic disc was dilated, with C/D ~ 0.6. The patient was referred for urgent laser iridotomy in the left eye prior to lens removal surgery.

Biometric measurements of the left eye gave the following values: AL 19.8 mm, anterior chamber depth 1.69 mm, corneal diameter 11.1 mm; the patient was diagnosed with nanophthalmos. Based on calculations, an IOL with a power of +32D was selected. Because of the patient's short eyeball, very shallow anterior chamber, presence of adhesions, and high risk of intraoperative and postoperative complications, a decision was made to perform phacovitrectomy in the left eye.

The patient was operated under periocular anesthesia. Following primary 23G vitrectomy with partial excision of the anterior vitreous and ocular decompression at 12 o'clock, a 1.2 mm paracentesis was done with a scalpel. Using a spatula and viscoelastic, the posterior adhesions were separated, resulting in pupillary dilation. Due to iris prolapse, ocular decompression through the vitrectomy port was repeated. The later stages of the procedure and the postoperative period proceeded normally, without any complications.

Follow-up assessment on the first day after surgery showed Vod = 5/12 sc, Tos = 11 mgHg without anti-glaucoma medications. In view of the COVID-19 pandemic, the patient did not report for further postoperative visits. Contacted by telephone, she reported no complaints.

CONCLUSIONS

Cataract phacoemulsification plays an important role in the treatment of patients with nanophthalmos. In this group, it serves as an anti-glaucoma procedure. Removing a relatively large lens eliminates anatomical factors that may potentially lead to angle closure and reduces intraocular pressure. By removing opacification from the visual axis and correcting significant hyperopia, the procedure contributes to an improvement of vision.

However, despite advances in minimally invasive surgery, patients with nanophthalmos remain at high risk of complications such as anterior chamber shallowing with ocular tissue prolapse, damage to the endothelium, iris and lens capsule, or suprachoroidal hemorrhage.

Our experience to date indicates that the described vitrectomy technique reducing positive vitreous pressure allows safe cataract phacoemulsification in eyes with very shallow anterior chamber and intraocular pressure abnormalities. It also optimizes the anatomical conditions for lens removal and IOL implantation, and provides a way to respond promptly and effectively to any complications that might arise.

Thus, it enables phacoemulsification to be performed in patients with an extremely shallow anterior chamber who previously had to be managed by extracapsular cataract extraction or vitrectomy with lensectomy.

By using a small diameter port, the procedure is minimally traumatic to the ocular surface. The patient comfort and healing time are similar to those noted after phacoemulsification alone. The relatively simple technique can be employed not only by vitreoretinal surgeons.

The literature includes case reports of safe and successful phacovitrectomy performed in patients with a shallow anterior chamber and abnormal intraocular pressure secondary to primary or lens-induced angle closure. However, further studies on a larger group of patients are needed to fully assess the benefits and risks associated with this therapeutic modality.

DISCLOSURE

The authors declare no conflict of interest.

References

1. Singh OS, Simmons RJ, Brockhurst RJ, Trempe CL. Nanophthalmos: a perspective on identification and therapy. Ophthalmology 1982; 89: 1006-1012.
2. Elder MJ. Aetiology of severe visual impairment and blindness in microphthalmos. Br J Ophthalmol 1994; 78: 332-334.
3. Day AC, MacLaren RE, Bunce C, Stevens JD, Foster PJ. Outcomes of phacoemulsification and intraocular lens implantation in microphthalmos and nanophthalmos. J Cataract Refract Surg 2013; 39: 87-96.
4. Warburg M. Classification of microphthalmos and coloboma. J Med Genet 1993; 30: 664-669.
5. Carricondo PC, Andrade T, Prasov L, et al. Nanophthalmos: A Review of the Clinical Spectrum and Genetics. J Ophthalmol 2018; 2018: 2735465.
6. Potop V. Small eye – a small stump which can challenge and tilt a great surgery. Rom J Ophthalmol 2016; 60: 138-144.
7. Weiss AH, Kousseff BG, Ross EA, Longbottom J. Simple microphthalmos. Arch Ophthalmol 1989; 107: 1625-1630.

8. Relhan N, Jalali S, Pehre N, et al. High-hyperopia database, part I: clinical characterisation including morphometric (biometric) differentiation of posterior microphthalmos from nanophthalmos. Eye (Lond) 2016; 30: 120-126.
9. Azuara-Blanco A, Burr JM, Cochran C, et al. The effectiveness of early lens extraction with intraocular lens implantation for the treatment of primary angle-closure glaucoma (EAGLE): study protocol for a randomized controlled trial. Trials 2011; 12: 133.
10. Dada T, Kumar S, Gadia R, et al. Sutureless single-port transconjunctival pars plana limited vitrectomy combined with phacoemulsification for management of phacomorphic glaucoma. J Cataract Refract Surg. 2007; 33: 951-954.
11. Noh HJ, Kim ST. Combined treatment of phacoemulsification and single-port limited pars plana vitrectomy in acute angle-closure glaucoma. Int J Ophthalmol 2019; 12: 974-979.
12. Yamani A, Wood I, Sugino I, et al. Abnormal collagen fibrils in nanophthalmos: a clinical and histologic study. Am J Ophthalmol 1999; 127: 106-108.
13. Chronopoulos A, Thumann G, Schutz J. Positive vitreous pressure: Pathophysiology, complications, prevention, and management. Surv Ophthalmol 2017; 62: 127-133.
14. Fukuchi T, Sawada H, Seki M, et al. Changes of scleral sulfated proteoglycans in three cases of nanophthalmos. Jpn J Ophthalmol 2009; 53: 171-175.
15. von Graefe, A. Beiträge zur Pathologie und Therapie des Glaucoms. Archiv für Opthalmologie 1869; 15: 108-252.
16. Cronemberger S, Calixto N, Diniz Filho A. Malignant glaucoma. Rev Bras Oftalmol 2012; 71: 331-337.
17. Jung KI, Yang JW, Lee YC, et al. Cataract surgery in eyes with nanophthalmos and relative anterior microphthalmos. Am J Ophthalmol 2012; 153: 1161-1168.e1.
18. Steijns D, Bijlsma WR, Van der Lelij A. Cataract surgery in patients with nanophthalmos. Ophthalmology 2013; 120: 266-270.
19. Carifi G, Safa F, Aiello F, et al. Cataract surgery in small adult eyes. Br J Ophthalmol 2014; 98: 1261-1265.
20. Lemos JA, Rodrigues P, Resende RA, et al. Cataract surgery in patients with nanophthalmos: results and complications. Eur J Ophthalmol 2016; 26: 103-106.
21. Olson RJ, Braga-Mele R, Chen SH, et al. Cataract in the Adult Eye Preferred Practice Pattern®. Ophthalmology 2017; 124: P1-P119.
22. Hoffman RS, Vasavada AR, Allen QB, et al. Cataract surgery in the small eye. J Cataract Refract Surg 2015; 41: 2565-2575.
23. Yu YS, Kim SJ, Choung HK. Posterior chamber intraocular lens implantation in pediatric cataract with microcornea and/or microphthalmos. Korean J Ophthalmol 2006; 20: 151-155.
24. Ashok Kumar D, Agarwal A, et al. Implantation of glued intraocular lenses in eyes with microcornea. J Cataract Refract Surg 2015; 41: 327-333.
25. Jethani JN, Jethani M. Custom made small sized Iol in Microcornea in children and adults. Proceedings of the 75th All India Ophthalmological Society Scientific Commitee 2017, Feb 16-19; Jaipur, India.
26. Nossair AA, Ewais WA, Ali LS. Retrospective Study of Vitreous Tap Technique Using Needle Aspiration for Management of Shallow Anterior Chamber during Phacoemulsification. J Ophthalmol 2017; 2017: 2801025.
27. Chalam KV, Gupta SK, Agarwal S, et al. Sutureless limited vitrectomy for positive vitreous pressure in cataract surgery. Ophthalmic Surg Lasers Imaging 2005; 36: 518-522.
28. Warrier SK, Jain R, Gilhotra JS, et al. Sutureless vitrectomy. Indian J Ophthalmol 2008; 56: 453-458.
29. Mohamed S, Claes C, Tsang CW. Review of Small Gauge Vitrectomy: Progress and Innovations. J Ophthalmol 2017; 2017: 6285869.