DIAGNOSTIC AND SURGICAL TECHNIQUES

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Cataract Surgery in the Small Adult Eye

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Abstract. Microphthalmos is a rare condition that is often associated with several other ocular abnormalities. Given the considerable differences between microphthalmic and anatomically normal eyes, cataract surgery is technically demanding in these patients, and special attention must be given to adequate preoperative planning of these procedures. Furthermore, the unique nature of these surgeries creates a particular subset of intraoperative and postoperative complications. However, with the advent of piggyback intraocular lens placement, the visual outcomes of cataract surgery in small adult eyes have improved considerably over the past 20 years. This review discusses the nature of the microphthalmic eye, and addresses proper pre-, intra-, and postoperative care of the microphthalmic patient. (**Surv Ophthalmol 51**:153–161, 2006. © 2006 Elsevier Inc. All rights reserved.)

Key words. cataract • interlenticular opacification • intraocular lens • microphthalmos • nanophthalmos

Introduction

DEFINITION OF MICROPHTHALMOS

Microphthalmos is a rare (0.046–0.11% of ophthalmology patients), complex condition with serious visual sequelae.[43] Simple microphthalmos is a clinical state in which an eye is small but otherwise anatomically intact. Conversely, pure microphthalmos (nanophthalmos) is marked by small (14–17 mm), hypermetropic (+13 to 18 diopters) eyes with microcornea.[3] These eyes also have large crystalline lenses and a shallow anterior chamber.[51] The thickened sclera in these eyes may block the vortex veins, creating choroidal congestion, uveal effusion (Figs. 1 and 2), and serous retinal detachment. Alternatively, complex microphthalmos describes a small eye with marked anatomic malformations, including chorioretinal colobomas, persistent hyperplastic primary vitreous, and retinal dysplasia.[2,4,10,15,33,54] Given this wide spectrum of developmental abnormality and subsequent clinical severity, cataract extraction remains a difficult challenge in these eyes and requires special considerations; as such, we attempt to describe these disorders and their associations and to discuss the approaches necessary to perform surgery in patients with these complications.

RELATION OF MICROPHTHALMOS TO OTHER OCULAR DISORDERS

In light of the abnormal development of the microphthalmic eye, several studies have shown correlations between microphthalmos and other

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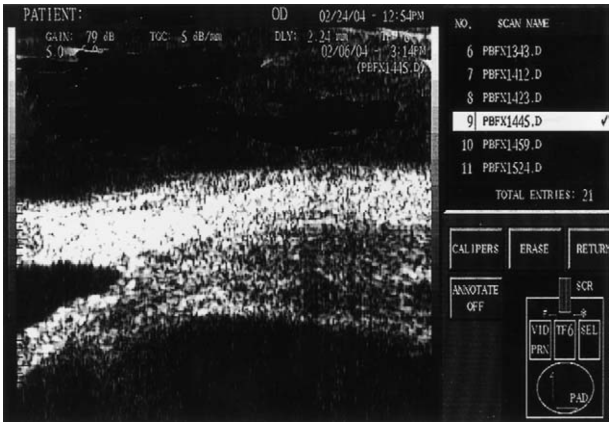

Fig. 1. Ultrasound biomicroscopic image of choroidal effusion and thickening.

eye disorders (Table 1). These patients often have concomitant nystagmus.[44] Corneal guttata are also fairly common.[1] Posterior synechiae may develop, and microphthalmic eyes often require intraoperative synechialysis. In a review of microphthalmos and co-existent eye disease, Auffarth et al noted a 77.4% incidence of glaucoma.[41] A later analysis of a family with autosomal dominant transmission of nanophthalmos revealed a 54.5% prevalence (12 out of 22 patients) with narrow-angle glaucoma.[32] This finding often results from the combination of a shallow anterior chamber and a relatively large crystalline lens; as such, the anterior chamber becomes crowded and may narrow further, leading to angle closure. In fact, angle-closure glaucoma may alert the clinician to the possibility of microphthalmos.[26,27] Given the technical difficulty inherent to intraocular surgery in small eyes, some authorities have advocated laser iridotomy or iridoplasty for the management of this glaucoma.[26] However, cataract extraction may also alleviate the angle closure.

Nonetheless, alternative forms of glaucoma may also develop. Given the high rate of pseudoexfoliation in microphthalmic eyes (16.1% in a study by Auffarth et al[41]), open-angle glaucoma may also ensue.[26] The ciliary body may be pushed anteriorly or rotated by choroidal detachment, yielding both angle-closure and malignant glaucoma.[27]

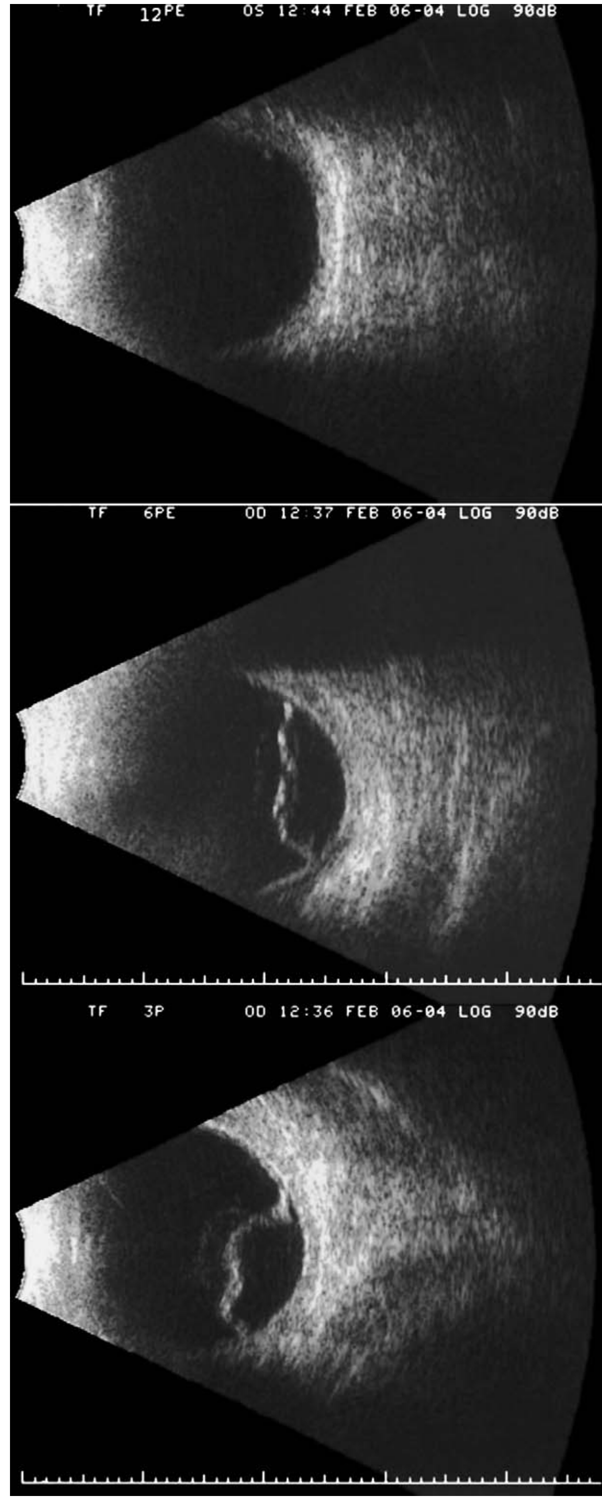

Fig. 2. B-scan ultrasonographic image of choroidal effusion.

Surgical Intervention

INDICATIONS FOR CATARACT SURGERY IN SMALL ADULT EYES

Cataract surgery in microphthalmos has traditionally been fraught with complications, and, as such, is a relatively recent innovation and the surgical outcomes appear to parallel our enhanced success in cataract surgery as a discipline. In 1982, Singh et al reported their experience with cataract extraction in six eyes, and noted improved vision in only three eyes.[43] They thus concluded that intraocular surgery had an unacceptably high complication rate and often produced disastrous results. Nonetheless,

TABLE 1

Ocular Disorders Associated with Microphthalmos

Nystagmus
Corneal guttata
Posterior synechiae
Glaucoma (angle closure, pseudoexfoliation, malignant)

surgeons currently experience significantly better outcomes after cataract surgery in microphthalmic eyes. Given the potential for poor outcomes and the technical difficulty of performing these procedures, a careful evaluation of the indications for cataract extraction in patients with microphthalmos is necessary before operating.

Despite markedly improved results with modern cataract surgery techniques (Shugar JK: Microphthalmos and piggyback IOL. www.ophthalmichyperguides.com; and Shugar JK: Cataract surgery in nanophthalmic/crowded eyes. Spotlight on Cataract Surgery 2002: Pearls on Handling Complicated Cases and Complications. American Academy of Ophthalmology. Orlando, FL. October 21, 2002), patients should be forewarned that cataract extraction in microphthalmic eyes is a challenging procedure (i.e., the aforementioned crowded anterior chamber, risks of uveal effusion, potential for glaucoma, and need for synechiolysis), and may not always improve vision. In light of the technical difficulties in performing such an operation, the procedure should only be undertaken once the functional indications for cataract extraction are met, and should always be handled by an experienced surgeon. Clearly, a balance must be struck between the degree of surgical difficulty and the long-term risks of angle closure.

Objective measurements of patient readiness for cataract extraction may be necessary, including the Daily Vision Scale[28] and the VF-14[46] questionnaires. Thorough examination of the vision and visual potential should be undertaken prior to surgery. Given the aforementioned ocular disorders that are associated with microphthalmos, one must rule out uveal effusion and retinal detachment prior to surgery, although these problems are rare. Preoperative B-scan echography may thus be useful to assess the integrity of the fundus.[30,35] Oetting also recommends the use of a potential acuity meter or merely inquiring about a history of prior better vision to determine the visual potential.[30]

REVIEW OF FORMULAS FOR IOL SELECTION

Overview of Formulas of IOL Calculation for Anatomically Normal Eyes

Several formulas have been developed to calculate the appropriate strength of the intraocular lens for implantation after cataract extraction. There is no current standard, and the formula that is employed remains largely a matter of the preference of the surgeon. Nonetheless, studies have attempted to determine how these formulas perform under conditions of high hyperopia, and careful analysis of the origins of these calculations may better enable clinicians to prepare for optimal surgical outcomes.

The SRK series of formulas is based on empiric regression.[34–38] These formulas involve mathematical analysis of large samples to yield an equation that includes an empirically derived constant that accounts for the lens, the keratometry results, and the total axial length. Consequently, the total IOL power can be calculated in a simple, user-friendly manner. The initial formula was revised in 1988, and the SRK II model was developed, based on the best fit for extremes of axial length.[38] Subsequent reconsideration of this formula resulted in the SRK/T model, which attempted to enhance the techniques by which anterior chamber depth was assessed and account for retinal thickness and corneal refractive power; as such, it employs nonlinear terms as its base, but also draws from empiric regression.

Conversely, theoretical formulas have also been proposed to calculate the necessary IOL for implantation. The classic example of this type of model is the Holladay series of formulas.[5,12,22,23] These calculations were powered to specifically note outlying axial lengths and keratometries and to provide clinicians with a factor that accounts for consistent trends in an individual's surgical experience. A subsequent modification (Holladay II) was designed to account for specific corneal diameter, anterior chamber depth, and phakic lens measurements. The ability to accurately locate the IOL's optical plane in its alignment with the cornea and fovea is central to the utility of the Holladay formulas. Because the axial length and corneal curvature are evaluated in this formula, it accurately calculates the IOL's power. Furthermore, the assessment of anterior chamber depth, lens thickness, and corneal diameter all enable improved accuracy. The "surgeon factor" in the Holladay formulas allows for corrections for lens style, positioning, wound closure, measuring instrumentation, and miscellaneous factors to varying degrees. Given the degree of variation found in microphthalmic eyes and the notion that the theoretical formulas best assist in cases of statistical outliers, these formulas are generally favored in cases of microphthalmos (Holladay JT: Presentation at the annual meeting of the Association of Cataract and Refractive Surgeons, Boston, MA, 1997).

Overview of Formulas for IOL Calculation for Small Adult Eyes

IOL selection in microphthalmic eyes requires special consideration, and it differs appreciably from selection in normal adult eyes. Standard ultrasound devices assume an average velocity that is accurate for the majority of normal eyes, but does not apply to smaller eyes.[22] However, microphthalmos is marked by relatively large crystalline lenses and sound travels faster through the lens than through vitreous. Consequently, non-gated A-scan devices will underestimate the average length of microphthalmic eyes.[30] Given that errors in measurement reflect a greater difference in the total axial length of the microphthalmic eye, absolute accuracy is required to prevent postoperative distortion. Ideally, a gated ultrasound device with immersion technique should be used to enhance the accuracy of measurement of axial length.[5,20,30]

Anatomic differences between normal and microphthalmic eyes also create difficulties. High keratometry levels are commonly encountered in microphthalmic eyes.[11] Anterior chamber depth is small in the microphthalmic eye,[9] meaning that IOL formulas that rely on a fixed anterior chamber depth assumption will create significant error in IOL selection. Furthermore, the anterior and posterior chamber depths may vary independently of one another, creating an increased demand for precision.

Several studies have compared the various formulas employed for IOL selection in extremely short eyes, and multiple different formulas contain variables that enhance a surgeon's ability to properly choose a lens. Inatomi et al performed cataract surgery on six patients with axial lengths of 19 mm or less, and compared the postoperative refraction values with those that were predicted by several different formulas.[25] Although their study had a small sample size, their results favored the theoretical formulas. A subsequent study used a sample of 136 hyperopic patients that required at least 30 diopters of emmetropic power and tested the role of the Holladay II formula.[12] They concluded that this formula produced excellent results, with a mean postoperative spherical equivalent refraction of −0.67 diopters.

The Hoffer Q formula has also proven to be a valuable tool for IOL consideration in small eyes. This formula employs consideration of the axial length, corneal curvature, and anterior chamber depth. Because it specifically assesses the issue of anterior chamber depth, it may well be more accurate than less exacting formulas. Later work compared the Holladay II with the Hoffer Q and SRK/T formulas in 10 eyes with axial lengths of less that 22 mm,[21] and found that the Hoffer Q and Holladay II formulas perform equally well for short eyes. Hoffer noted that the Holladay II formula requires several data inputs (e.g., requirements of axial length, corneal power, and A-constant in the Hoffer Q). Given the simplicity of his formula, he thus planned to continue to use the Hoffer Q for cataract extraction in moderately short eyes, but would use the Holladay II technique for extremely short eyes (i.e., < 18 mm), in which the additional specifications may yield enhanced postoperative results. Furthermore, several authorities support the use of the theoretical Holladay II formula in the management of microphthalmic eyes with cataract,[21,25,30] in order to account for variation in the anterior segment.

Nonetheless, support continues to exist for the empirical formulas. The best postoperative results in the aforementioned study be Inatomi et al occurred via analysis of the SRK/T formula,[25] although this study includes only a limited number of cases.

TYPES OF IOLS USED IN MICROPHTHALMOS

PMMA Posterior Chamber IOLs

Theoretically, polymethylmethacrylate posterior chamber intraocular lenses provide certain key advantages in microphthalmos. Small eyes require high-power lenses, and such PMMA lenses are available. Furthermore, a single lens can be implanted (vs. the two lenses that are required in the piggyback format), thereby decreasing the amount of lens material that must be placed into an already-crowded anterior chamber. As such, Faucher et al performed cataract surgery on six eyes of four microphthalmic patients using PMMA lenses, and found that each patient had either visual stability or improvement.[11]

Nonetheless, the use of PMMA lenses is fraught with peril, and, therefore, their use is not the standard of care. The insertion of large, single-pieced lenses necessitates the creation of a large wound, thereby increasing the chance of postoperative complications and astigmatism. Furthermore, the small anterior chamber that is commonly encountered in microphthalmos results in greater technical difficulty in the implantation of PMMA lenses.[7,19]

Foldable Posterior Chamber IOLs

In response to the complications inherent to rigid, single-pieced IOLs, foldable IOLs were developed. A variety of materials have been employed. Silicone IOLs provide a high index of refraction, with a subsequently thin optic.[6] Because of their surface properties, these lenses require technical precision; they unfold rapidly, creating poor control and predisposing to surgical trauma. However, later advancements in silicone IOLs and injector systems have diminished this possibility considerably.

Acrylic IOLs have an even higher index of refraction, creating an even thinner lens. Nonetheless, these lenses unfold in a more reliable fashion, and are thus often favored in cataract surgery in microphthalmic patients.

Piggyback IOLs

Piggyback PMMA IOLs

Microphthalmic eyes require high-power lenses (generally greater than the 40 diopters that is the current limit of available foldable IOLs).[8,13,17,29,31] Single IOLs are available that provide such power, but the thickness and subsequent steep radii required for such lenses creates significant optical aberrations and blurring. As such, two lenses can be placed to achieve the same degree of lens power without the complications that are inherent to a single, thick, high-powered lens and with better optical results.

Gayton and Sanders first reported their experience with the implantation of piggyback PMMA IOLs in 1993.[17] Their patient had bilateral microphthalmos and nuclear sclerosis. IOL calculations suggested that they could achieve emmetropia with 46 diopters of lens power; given that such a lens was unavailable, they placed two lenses (one in the capsular bag, one in the ciliary sulcus) with satisfactory results.

Piggyback Acrylic IOL

Given that they are thinner than PMMA lenses, acrylic IOLs are thought to be useful for implantation into microphthalmic eyes. The first use of piggyback foldable intraocular lenses was reported by Shugar et al.[41] In their series, six eyes of three hyperopic patients underwent cataract extraction followed by the placement of multiple lenses. The ultimate visual acuity was markedly improved in these eyes.

Oshika et al reported their experience with the placement of two acrylic IOLs into the capsular bag in five eyes of three patients.[31] All of their patients experienced improvement in visual acuity. However, they noted that each eye remained significantly hyperopic.

Findl et al used specular microscopy to note a zone of contact between piggybacked acrylic IOLs.[14] This zone consists of a dark central zone with concentric circles that they postulated to consist of gaps between the contact regions. At this interface of contact, the total power of the lenses is decreased (and is consequently used for distance vision), whereas surrounding area is used for near vision. As such, patients with piggyback lenses experience increased depth of field.[39]

Piggyback Silicone IOLs

Shugar recommends the use of evenly divided piggyback silicone IOLs in microphthalmos.[39] In order to decrease the contact zone between the lenses and minimize the biocompatibility of the interpseudophakos interface, he suggests the use of lenses that are made of RMX-3, as they are thicker (due to a lower index of refraction).

Piggyback Bag/Bag Implantation Versus Piggyback Bag/Sulcus Placement

Gayton and Sanders first reported the use of piggyback IOLs in 1993,[17] and they obtained satisfactory results with the placement of two PMMA lenses into the capsular bag. Shugar et al and Oshika et al[31] followed this work by implanting two acrylic lenses in the capsular bag in a series of microphthalmic eyes with significant improvement in vision. However, these authors expressed several concerns about this technique. They felt that placing both lenses in the capsular bag may result in a decrease in the power of the posterior lens (by pushing it posteriorly), thereby resulting in postoperative hyperopia. This concept is bolstered by the work of Holladay et al,[22] who determined that—when both lenses are in the capsular bag—the posterior lens is displaced by one lens thickness. In addition, Oshika et al postulated deformation at the interface of the two lenses, creating decreased total IOL power and optical distortion.[31] Finally, they cited the work of Findl et al by noting that the placement of both lenses in the bag may yield Elschnig pearls,[14] and may thus result in interlenticular opacification; this effect may distort the image, decrease total acuity, and create a hyperopic shift. Given these concerns, they recommended that surgeons place one IOL in the capsular bag and one in the ciliary sulcus.

Advantages of Piggyback IOLs (Table 2)

As previously noted, microphthalmic eyes require higher power IOLs (often exceeding 40 diopters of total power). The IOLs that are commonly available today generally do not exceed 40 diopters of strength, suggesting that piggyback IOLs may provide an easier method for surgeons to achieve the total lens strength required for emmetropia. Furthermore, high-powered single lenses are often marked by significant spherical aberrations, due to

TABLE 2

Piggyback Intraocular Lenses

Advantages	
	Ability to achieve required lens power
	Less spherical aberration (enhanced image quality)
	Multifocality
Disadvantages	
	Technical difficulty
	Interlenticular opacification

the steep radii needed to produce such a lens. Findl et al demonstrated the enhanced image quality of piggyback lenses over a single lens,[14] and Shugar corroborated this phenomenon (Shugar JK, Lee A, Shugar MC: Defocus curves for piggyback acrylic intraocular lenses in highly hyperopic eyes: omniopia? Presented at the Annual Meeting of the American Society of Cataract and Refractive Surgery, Boston, MA, 1997). Hull et al compared various lens shapes for short eyes and found that piggyback lenses afford the highest image quality.[24] Furthermore, they concluded that the optimal approach is to use two convex-plano lenses with the convex surfaces facing the cornea.

Anecdotal evidence suggests that piggyback approaches provide better depth of field. Findl et al explored this phenomenon with specular microscopy, and noted a central zone of contact between two acrylic lenses.[14] As such, the lenses create a central dark zone with surrounding concentric Newton rings. These rings were postulated to reflect gaps between the lenses, creating interference. The authors felt that the apposition of the lenses creates pressure, resulting in alterations in the optical properties of the lens system, yielding the dark zone. As such, the contact zone is marked by a change in the curvature of the lenses, thus reducing the refractive power of this system. They then suggested that the central could be used for distance vision, and that the surrounding area without contact may have a higher total power, and could therefore be used for near vision. As such, the piggyback system acts as a multifocal lens.

Disadvantages of Piggyback IOLs (Table 2)

A significant complication of bag/bag implantation is the development of interlenticular opacification (ILO). Gayton et al noted the growth of a membranous structure between the lenses after 2 postoperative years, and reported that this phenomenon results in decreased visual acuity.[16] This phenomenon is marked by the progressive proliferation of lens epithelial cells between the IOLs, and results in a hyperopic shift.[18,40,45,48] Although the opacification can be surgically removed in PMMA systems, ILO may necessitate the removal of the entire piggyback system in acrylic lenses, given their thickness.[53]

Considerable analysis into the pathogenesis of this condition has been fruitful. Werner et al demonstrated that the ILO consists of retained cortical material, and shows geographic changes along the lens surface.[52] Peripherally, the retained cortical material attaches to the lens, and appears to evolve as a function of the interlenticular architecture. The space between the lenses decreases from the periphery towards the center, and the opacified material flattens to become smaller and round in the mid-periphery. Further compression occurs towards the center, creating a flat zone. Trivedi et al further suggested that the two intraocular lenses form a closed microenvironment with the surrounding aqueous and epithelial cells, thereby leading the retained cells to the interlenticular space.[49]

Shugar and Schwartz characterized the development of ILO in three microphthalmic eyes.[42] Two patients each had two acrylic IOLs placed in the capsular bag in a piggyback array, while the third had a PMMA IOL piggyback system placed in the bag. All three developed Elschnig pearls between the lenses. The authors attempted to depict reasons for the hyperopic shift that develops with ILO, and felt that the posterior IOL may be displaced backwards by the pressure from the opacity. Nonetheless, the authors report that this phenomenon does not totally account for the entire shift. As such, they postulated that the piggyback system may push the IOL/capsule complex posteriorly by altering zonular tension.

The pseudophakic lens material employed in the placement of the IOLs appears to alter the incidence of ILO. Shugar notes that RMX-3 silicone has a very low index of refraction, and is thus thick (Shugar JK: Microphthalmos and Piggyback IOL. www.ophthalmichyperguides.com). Consequently, these types of lenses will have minimal contact zones and maximal distance between the lens peripheries. Conversely, acrylic lenses have higher rates of ILO. Shugar and Keeler have thus suggested that a silicone lens can be placed in the bag with an acrylic lens in the sulcus;[40] this approach reduces the biocompatibility of the interpseudophakos interface as well as increases the physical distance between the IOL surfaces (thereby reducing the scaffold for cellular ingrowth between the IOLs). Using the same logic, Grabow advocates the use of silicone lenses with the plates placed perpendicularly (Grabow HB: Polypseudophakia. Presented at the Annual Meeting of the American Society for Cataract and Refractive Surgery, Orlando, FL, 1996).

Multiple recommendations have been construed to minimize the development of this complication.

First, the capsule should be thoroughly cleaned to decrease the proliferation of lens epithelial cells (Chang D: Achieving a large capsulorrhexis for piggyback IOLs. Presented at the Annual Meeting of the American Society for Cataract and Refractive Surgery, Boston, MA, 2000). By creating an adequate size of capsulorrhexis, surgeons may prevent the migration of cells from the capsule to the lens. Alternatively, surgeons may choose to place one lens in the capsular bag and one in the sulcus. Gayton et al treated ILO with a YAG laser, which reduced glare and hyperopic shift.[16] Shugar advocates treating with laser by focusing at the anterior edge of the ILO, starting peripherally and working centrally (Shugar, JK: YAG laser lysis of interpseudophakos opacification. Presented at the Annual Meeting of the American Society for Cataract and Refractive Surgery, Boston, MA, 2000).

OPERATIVE COMPLICATIONS

Given the technical intricacy of operating on microphthalmic eyes, the delicate nature of intraocular surgery in eyes with markedly abnormal anatomy, and the lack of clear consensus as to the optimal intraoperative technique, cataract surgery in small eyes is both demanding and marked by several potential complications (Table 3). Villada et al noted the development of cystoid macular edema in three out of four microphthalmic eyes after cataract extraction, and thus recommended preoperative topical antibiotics, steroids, and NSAIDs along with oral NSAIDs and carbonic anhydrase inhibitors to avoid this complication.[50] In a 1987 case report, Susanna warned of the dramatic effects of rapid globe decompression, possibly resulting in uveal effusion with subsequent retinal detachment, vitreous hemorrhage, choroidal hemorrhage, and malignant glaucoma.[47] Jin and Anderson performed unsutured sclerotomy or sclerectomy prior to or during cataract extraction from nine small eyes to adequately drain the choroid, and reported that none of these eyes developed uveal effusion.[26] Nonetheless, Shugar has reported that he has successfully performed 100 cataract extractions in microphthalmic eyes without the involvement of these techniques, and has not had any cases of uveal effusion (Shugar JK: Microphthalmos and Piggyback IOL. www.ophthalmichyperguides.com). The difference in results between these approaches may be due to the benefits of the smaller corneal incision that is used in modern cataract surgery, suggesting that results may continue to improve with newer micro-incisional (1.5 mm) stab incisions. Corneal edema and the aforementioned interlenticular opacification have also been reported as significant complications of this surgery.

TABLE 3

Potential Operative Complications

Cystoid macular edema
Uveal effusion
Retinal detachment
Choroidal hemorrhage
Malignant glaucoma
Vitreous hemorrhage

OUTCOMES

The final visual outcomes of cataract surgery in microphthalmos have improved considerably from early reports. In 1982, Singh et al described their experience with surgery on six eyes of microphthalmic patients (all involving prophylactic sclerotomy).[43] Only half of these eyes had improved vision, whereas the other patients had retinal detachment, corneal edema, or phthisis. Five years later, Susanna reported a case of extracapsular cataract extraction with significantly improved results and without complications.[47] By 1990, Jin and Anderson documented nine successful cases of visual improvement after cataract extraction.[26] In the modern age, an anecdotal report from Shugar has indicated over 100 successful cases.

Overall, there are 88 cases of cataract extraction from microphthalmic eyes in the conventional medical literature. Seventy-two cases have reported acuities, with 63 (87.5%) of these resulting in visual improvement. One patient required IOL exchange to correct for errors in IOL power,[8] and another needed an exchange for ILO.[53] Conceivably, these results might be even more impressive if those cases, which involved the placement of a single lens, had the secondary placement of another IOL. Furthermore, postoperative PRK or LASIK could improve the corneal power, thereby enhancing postoperative vision. However, LASIK is extremely difficult in this population, and must be performed with a great deal of caution. Alternatively, conductive keratoplasty may be a reasonable means to control residual hyperopia. Finally, spectacles and contact lenses can be employed postoperatively to further improve vision.

Newer small-incision techniques may further enhance the surgical outcomes in microphthalmos. Meticulous phacoemulsification techniques allow for maintenance of the anterior chamber and the avoidance of globe decompression.

Clearly, these results indicate that the role of cataract surgery in microphthalmos has undergone considerable evolution and that such procedures are now viable options for patients with small eyes. Nonetheless, each step of preoperative planning and intraoperative manipulation must be precisely performed to achieve successful results. We recommend careful patient selection and a frank discussion of the potential risks and benefits with the patient. Furthermore, surgery must be timed to ensure that the cataract meets the functional criteria for intervention without advancing to a stage that will further complicate management. Evaluation of the patient's retina is critical, and surgeons should consider ultrasonography if needed. Many formulas exist to assist the surgeon in selecting the IOL, but the Holladay II is the most preferred method. We advise that surgeons create an adequate size of capsulorrhexis and place a piggyback IOL array with one lens in the bag and one in the ciliary sulcus to avoid ILO. Meticulous cleaning of the capsule and cortex will also help to diminish this complication. If ILO does occur, it should be treated with YAG laser. Postoperative management should include careful inspection for macular edema.

With optimal preoperative management, careful selection of the intraocular lens, meticulous surgical technique, and appropriate awareness of the potential intra- and postoperative complications, cataract surgery can be successfully performed in microphthalmic patients with excellent results.

Methods of Literature Search

In the preparation of our manuscript, we used the Ovid MEDLINE and PubMed search engines, including 1966 to 2005. Specifically, the terms *microphthalmos, small eye, nanophthalmos,* and *small adult eye* were combined with *cataract. Interlenticular opacification* and *piggyback intraocular lens* were separately checked. *Intraocular lens* was combined with *formula* and *calculation.* The bibliographies of the articles produced by these searches were further checked in order to ensure completeness. In cases of foreign literature for which no translation of the entire article was available, translations of the abstracts were used.

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