

Paediatric Aphakic Glaucoma: A Diagnostic and Management Challenge

V Swetha E Jeganathan^{1,2*} Alan Mulvihill³ and Donald Montgomery⁴

¹Department of Ophthalmology, The University Hospital Ayr, Scotland, UK

²The University of Edinburgh, Scotland, UK

³Princess Alexandra Eye Pavilion, Edinburgh, Scotland, UK

⁴Gartnavel General Hospital, Glasgow, Scotland, UK

*Corresponding author: V Swetha E Jeganathan, Department of Ophthalmology, The University Hospital Ayr, Dalmellington Road, Ayr KA6 6DX, Scotland, UK, E-mail: vswetha@ausdoctors.net

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Introduction

Pediatric aphakic glaucoma is a potentially blinding condition, which poses significant management challenges - the patient is young and treatment must aim to preserve vision for perhaps 80 years or more of life expectancy. The purpose of this study is to highlight that early detection is important to improve the prognosis for these patients and their families. Misdiagnosis of this condition may adversely affect vision preservation. However, diagnosis can be difficult, especially when children may demonstrate vague symptoms such as irritability, photophobia and epiphora which themselves may further impair clinical co-operation. Despite considerable advances in techniques employed in paediatric cataract surgery, aphakic glaucoma continues to occur and remains notoriously challenging to manage [1]. We present a case of glaucoma after cataract surgery that masqueraded as corneal infection which was challenging to diagnose and treat. Prompt recognition of pediatric aphakic glaucoma and intraocular pressure (IOP) control has resulted in a favorable clinical outcome, thus far.

Statement of Ethics

In accordance with the declaration of Helsinki, the patient provided informed consent prior to participation. We certify that all applicable institutional and governmental regulations concerning the use of human volunteers were followed during this research.

Case Report

Medical and ophthalmic patient history

A 16-month old male infant of African-Polish origin, presented to our Ophthalmology department with irritability, bilateral sore eyes, yellow purulent discharge and hazy cornea, following a recent contact lens (CL) change. The patient had a history of congenital cataracts, for which no identifiable cause was found. At the age of 2 months, the patient underwent right lensectomy, followed by 3 weeks later by left lensectomy. Both cataract surgeries included planned posterior capsulotomy and anterior vitrectomy. The patient was subsequently fitted with 30D CL bilaterally. His birth was at full term by normal vaginal delivery. He did not have any developmental issues, other ocular or systemic disorders. He lived at home with his parents and older brother. Neither parent had any ocular complaints nor was there a family history of glaucoma.

Clinical investigations and management

Approximately, 5 months following his initial right cataract surgery, the infant presented with bilateral hazy cornea. He had poor fixation to light in both eyes. The working diagnosis was CL keratitis, with paediatric aphakic glaucoma as a possible differential diagnosis. The patient was promptly commenced on topical ofloxacin 0.3%, in addition to travoprost (Travatan) 0.004% and cyclopentolate 0.5% eye drops and closely followed-up. An urgent examination under anaesthesia (EUA) was organised when the corneal oedema failed to resolve completely. The IOPs measured by Perkins tonometry were 28 mmHg (right) and 24 mmHg (left eye). The horizontal corneal diameters were 12.5 mm (right) and 12.0 mm (left). His axial length (AL) was 24.9 mm (right) and 21.7 mm (left). Refraction was + 8.50/1.00 × 180 (right) and + 14.50 (left). The optic nerve cup-to-disc (CDR) ratios measured 0.5 right and 0.3 left. The anterior chamber depth in both eyes was normal. Direct gonioscopy with Koeppel lens revealed open angles.

To provide IOP control, in addition to topical glaucoma medication: timolol- dorzolamide combination (Cosopt), travoprost (Travatan) and a weight appropriate dose of oral acetazolamide (Diamox). The patient underwent several repeated cyclodiode treatments to some success before ultimately requiring an Ahmed valve (FP7 model, New World Medical) implantation. The sequelae of events are summarised as Figure 1.

At his most recent EUA, his IOP remains stable (12 mmHg in the right and 10 mmHg left) with a functioning Ahmed valve and no complications noted. The measured horizontal corneal diameter was 13 mm (right) and 12.5 mm (left). His AL was 25.9 mm (right) and 21.9 mm (left). The CDR measured 0.5 right and 0.2 left eyes. The patient remains on timolol-dorzolamide and travoprost eye drops to his left eye only and wears a +13.5D CL (right) and + 19.5D (left eye).

Discussion

Aphakic glaucoma, the most common long-term complication following congenital cataract surgery, has an incidence between 15 and 45%, depending on the duration of reported post-operative follow-up [2]. We will review what has been published in literature and how this relates to our case. In our paper, we aim to provide guidelines for ophthalmologists treating glaucoma patients with paediatric aphakic glaucoma. We hope to contribute to existing ophthalmological knowledge by sharing our experience and the challenges encountered in managing this case and looking for the best possible treatment strategy.



Figure 1: Treatment intervention and IOP control.

Cataract surgery

In our patient early, uncomplicated cataract surgery and ethnicity may have been important risk factors. Lensectomy at an early age, especially during the first year of life has been shown to increase the risk of glaucoma, which is associated with a worse visual prognosis [3]. Retrospective studies have shown that the highest incidence of glaucoma occurs when cataract surgery was performed prior to one month or at five to six months of age [4]. The critical period for developing a fixation reflex is between 2 and 4 months of age. It is a fine balance of timing between early surgery for improved visual prognosis and delaying surgery to avoid the risk of glaucoma. Primary intraocular lens (IOL) implantation has not been shown to result in a lower rate of glaucoma, provide a more permanent correction and correcting most of the aphakia [5]. Kirwan et al. reported a glaucoma incidence of 33% in the aphakic group compared to 13% in the pseudophakic group, whereas Asrani and colleagues found an 11.3% incidence of glaucoma in the aphakic group compared to 0.27% in the pseudophakic group [6,7]. It is postulated that the IOL either provides a barrier from the toxic material of the vitreous (chemical theory) or supports the angle, preventing trabecular meshwork (TM) collapse (mechanical theory) [7]. The lower incidence of aphakic glaucoma in pseudophakic eyes may likely be a consequence of many surgeons avoiding inserting IOLs in high risk eyes. In contrast, CL often results in better optical correction and the dioptric power can be adjusted throughout life. A main drawback is its cost, risk of infection and potential loss.

Pathophysiological mechanisms

The pathophysiology of aphakic glaucoma remains to be elucidated. Our patient had early-onset glaucoma with open-angles. Open-angle glaucoma following congenital cataract surgery may be due to the interaction between TM cells and lens epithelial cells [8]. The role of the vitreous in aphakic glaucoma is poorly understood. In our case, it is likely that exposure of the angle to vitreous may have further caused an alteration to the aqueous outflow system.

Diagnostic challenges

Aphakic glaucoma poses a significant diagnostic challenge, as children often lack the classical manifestations and are uncooperative due to their visual symptoms. It can be extremely challenging, as in our case to measure the IOP with the child awake. EUA is usually required, but general anaesthesia in infants and young children, even in good health, carries a small but significant risk and should not be regarded lightly [9].

Clinical investigations

The mean aplanation IOP in children is lower than adults, but by the age of 10, they are equivalent [10]. Accurate IOP measurement in the paediatric population is often difficult, because it is subject to many influences including sedation, mode of airway securement during EUA, tonometer type and central corneal thickness [11]. This uncertainty is why clinical experience in addition to other ancillary examination (e.g. optic nerve, corneal diameter and AL) findings should be weighted more heavily when making judgements as to

whether the child's glaucoma is stable or progressing. The AL measurements with the A-scan ultrasound is especially useful to monitor the progression of glaucoma especially in children less than 5 years of age, who have more distensible globes [12]. Stabilisation or decrease in AL often occurs with IOP reduction. Normal black children, tend to have thinner corneas [13]. However, unlike adults, one should not adjust the measured IOP based on the CCT. Instead, children with thin corneas should be monitored more closely on a lowered target IOP.

Most general anaesthetics tend to lower IOP by variable amounts and at variable times after administration. Some ophthalmologists prefer to use ketamine, rather than sevoflurane in children for IOP measurement, as sevoflurane appreciably lowers IOP [14]. Furthermore, the IOP should be measured as soon as possible following induction of the anaesthesia, to get an accurate measurement. Many tonometers have been shown to estimate IOP inaccurately in children [15]. The Icare (Icare Finland Oy; Helsinki, Finland) rebound tonometer although useful in clinical practice without the use of anaesthetic eye drops, tends to overestimate IOP in those with thick corneas when compared to the Perkins (hand-held Goldmann applanation) tonometer [16]. Moreover, the child needs to be upright for IOP measurement in a rebound tonometer, and cannot be used in our child with contact lenses. CCT can further affect IOP measurements and patients with aphakic glaucoma tend to have significantly thickened corneas [17].

Management options

The treatment of paediatric aphakic glaucoma is challenging and communication with parents must be clear and informative to establish the trust for a child's often prolonged care. Additionally, there are important secondary management issues unique to the paediatric population that need to be addressed including increased IOP which may cause myopic refractive errors, corneal scarring from resolved corneal oedema which can result in induced astigmatism, strabismus from glaucoma surgery or as a result of sensory vision loss, and amblyopia. Medical management is the first line of treatment of aphakic glaucomas with open angles, but surgical intervention may be necessary if inadequate IOP control persists. Prompt peripheral iridectomy with possible synechiolysis is necessary as management of angle closure glaucoma in an aphakic eye.

Medical therapy

Medical management is often first line or as an adjunctive to maximize IOP lowering in addition to surgery. To date, the most useful topical medications in children are beta blockers and carbonic anhydrase inhibitors. Issues in medical management include side effects of topical treatment and compliance. Acetazolamide, a carbonic anhydrase inhibitor, however, is not ideal for long-term use due to potential for growth suppression, chronic fatigue and liver toxicities. Moreover, acetazolamide in infants is associated with hypercapnea from renal acidosis, dehydration and anorexia [18]. Due to ethical considerations, children are often not included by regulatory agencies in studies for the approval of glaucoma drugs. The adverse effects of medications are depending on the age and weight of the child. Plasma levels in children especially less than 2 years of age, after timolol 0.25% has been greatly exceed than in adults given 0.5%, which may increase the risk of side effects such as bronchospasm and bradycardia [19]. Therefore, punctal occlusion should be used. Travoprost eye drops may result in conjunctival redness, periocular pigmentation and ocular

irritation. Some medications can have life-threatening side effects in young children. Brimonidine, a selective alpha-adrenergic receptor, is contraindicated as it is associated with extreme fatigue and somnolence. Some children with aphakic glaucoma also do not respond well to latanoprost (Xalatan), a prostaglandin analogue, presumed secondary to TM immaturity, which does not mature until the age of 8 years of age [20]. Moreover, the ocular hypertensive response with steroids in younger children can be more severe with a more rapid onset [21].

Surgical interventions

When medical treatment fails, surgery is required and options include trabeculectomy, glaucoma drainage devices (GDD) and cyclodestructive procedures. Comparisons of various interventions are difficult because of different success criteria used and follow up duration. Repeat surgery is generally the norm and parents should be counselled in advance to have realistic expectations. The role of trabeculectomy in treating paediatric aphakic glaucoma has largely been superseded by GDD. Trabeculectomy without the use of adjunctive antifibrotic agents (e.g. Mitomycin C) have been largely unsuccessful [22]. Antifibrotics however are associated with increased risk of serious complications such as late-onset- bleb-related-endophthalmitis, which occurs more frequently in young children and with CL use [23].

Cyclodestructive procedures

Cycloablative procedures include diode laser cyclophotocoagulation and endocyclophotocoagulation. Diode laser is portable, compact, better tolerated, with quicker recovery and safer than Nd:YAG laser or cryotherapy. In high risk cases, cyclodiode is a safer option than surgery. Cyclodiode treatment can be used effectively in eyes with good visual acuity, although response may be temporary with apparently low risk of serious complications [24]. Retreatment frequently results in a more sustained IOP control, but may increase the likelihood of significant sight-threatening complications including retinal detachment and phthisis [25]. A 79% success rate was attained with cyclodiode therapy in those with aphakic glaucoma, with 41% reduction in IOP following one treatment, with its effect lasting for a longer duration those phakic eyes [26]. The effect of cyclodiode on subsequent surgery is unknown with some reporting lower IOP following GDD implants and others reporting extensive conjunctival scarring have made drainage procedures ineffective [2,27].

Endocyclophotocoagulation has been shown to have success rates of 34% following one treatment, increasing to 43% with multiple treatments [28]. The biggest drawback is that it is an invasive procedure and primary results do not seem to support an extended role at this time.

Glaucoma drainage device (GDD)

GDD are an effective option for aphakic paediatric glaucoma. Newer devices are smaller and more biocompatible. GDD are better implanted sooner rather than later in the hope of achieving, early definite IOP control. Tube shunt surgery for children is technically similar to adults, but the GDD plate can be trimmed to a more appropriate size for the paediatric eye. A hypertensive effect usually occurs around one month, due to fibrosis around the valve site. Drainage surgery may be complicated by hypotony when the eye is

large and has a thin sclera or from failure to control IOP caused by an aggressive healing response [29].

The Ahmed valve offers the advantage of immediate IOP lowering, which is a potential advantage in a patient with an oedematous cornea from an amblyopia perspective. Pakravan et al. reported success rates with the Ahmed valve in treating aphakic glaucoma as 66.7% [30].

Although GDD offer the most effective long term treatment for IOP control in refractory cases, complications occur frequently, related to the drainage plate or malpositioning of the drainage tube [31]. Children are particularly prone to extrusion and exposure of the implant from changes in the ocular dimensions following successful IOP control, normal growth and development, the elastic nature of the paediatric eye and eye rubbing. Exposure of GDD is the main risk factor for endophthalmitis and necessitates revision of the device. Corneal decompensation is another long-term risk given the potential lifespan of this population.

Conclusions

Despite considerable advances, the diagnosis and management of aphakic glaucoma still poses a significant clinical challenge. Two thirds of aphakic children eventually end up with a mean visual acuity of $\leq 6/120$, secondary to blindness from amblyopia, poor IOP control from medication compliance or surgical complications [32]. Lifelong follow-up is necessary. The physical and emotional effects of treatment including multiple hospital visits on the child and their family must always be borne in mind. A holistic management of patient care involving a multidisciplinary team approach is required to optimise visual prognosis.

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