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Case report

Bilateral trifocal IOL implantation in a pediatric case of cataract following steroid-therapy for acute lymphoblastic leukemia

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ABSTRACT

Purpose: To present the case of a 9-year-old child with bilateral posterior subcapsular cataract developed through steroid treatment for acute lymphoblastic leukemia. Cataract surgery with trifocal intraocular lens implantation was performed in both eyes.

Observations: Uncorrected distance visual acuity increased from +0.3 and + 0.4 logMAR preoperatively to 0.00 and + 0.04 logMAR after surgery. Binocular uncorrected values for intermediate and near visual acuity were −0.04 logMAR and 0.02 logMAR after surgery, respectively. The patient did not report side effects like halos or glare and was able to participate in his daily activities (school and sports) without spectacles.

Conclusions and Importance: This report represents the first description of a bilateral implantation of trifocal intraocular lenses in a pediatric cataract case with restoration of visual function in far, intermediate and near distance. Trifocal intraocular lenses to compensate for the loss of accommodation can be an option in selected cases of children with cataract.

1. Introduction

The crystalline lens of children has the ability to change its dioptric power to acquire a sharp image in different distances. A nine year old has an amplitude of accommodation of about 10 D.[1] As the prognosis of acute lymphoblastic leukemia in children is increasingly improving, targeting long-term side effects that reduce patient's quality of life is getting more important.[2] Early cataract formation is a common side effect of steroids that are part of most of the leukemia treatment regimes.[3] By treating these patients in order to restore clear vision, the cataract surgeon sacrifices the capability of the natural lens to accommodate. Today there is a large variety of multifocal intraocular lens (MIOL) models that can provide patients with pseudo-accommodation. Only few attempts have been made to apply this concept in pediatric cataract cases. Results for implantation of bifocal diffractive and refractive intraocular lenses show promising results in children with monolateral or bilateral cataract.[4–6] Current models of trifocal IOLs offer excellent and predictable results to restore functional unaided visual acuity in far, intermediate and near distance.[7,8] This principle is used for presbyopia correction and could be transferred to pediatric cataract cases to offer functional rehabilitation to those young patients that have lost their capability to accommodate due to the surgery. Differences in the anatomy and physiology of children, e.g. larger pupil diameter, increased healing reaction or incomplete eye growth, need to be considered when using lenses with these optics in pediatric cases.[9,10] Furthermore, the possibility of amblyopia should be taken into account. Since multifocal IOLs split the incoming light energy on different foci, a loss in contrast sensitivity might occur.[11,12] As amblyopia also causes reduction in contrast sensitivity, these multifocal lenses should not be considered in patients where amblyopia is expected.[13] In this case report we present a child with bilateral steroid-induced cataracts and subsequent bilateral implantation of trifocal intraocular lenses.

2. Case report

A 9-year old male patient (year of birth: 2008) presented to our clinic early in 2017 with bilateral posterior subcapsular cataract. The patient had a history of acute lymphoblastic leukemia, first diagnosed in 2012. He was successfully treated with chemotherapy and stem cell transplantation. The child had suffered from a graft-versus-host-disease

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after transplantation. Several times during his treatment the medication regime included steroids. At the time of presentation to our clinic the oncological and general condition of the young patient was good. The patient was significantly disturbed by a decreased visual quality. Uncorrected distance visual acuity (UDVA) was +0.3 logMAR for the right and +0.4 logMAR for the left eye. Corrected distance visual acuity (CDVA) for right and left eye were +0.2 logMAR with 0.00–0.50 × 3 correction and +0.3 logMAR with +0.50–0.25 × 180 correction, respectively. Anterior segment examination showed bilateral posterior subcapsular cataract in otherwise healthy eyes. We had no evidence for amblyopia. We recommended cataract surgery in both eyes to restore good visual acuity. Due to the patient's young age the parents were provided with detailed information about possible complications and benefits of the procedure. Special attention was paid to discussion of the loss of accommodation and future treatment of posterior capsule opacification (PCO). Furthermore, the risk of potential future changes in refraction, especially the development of myopia, and the various treatment options (spectacles, corneal refractive surgery, implantation of supplementary IOLs) in such a case was discussed extensively. The different options for posterior chamber IOLs were also presented to the family. After careful consideration, it was decided to perform bilateral femtosecond laser assisted cataract surgery with subsequent implantation of trifocal IOLs.

The axial lengths measured using the IOLMaster 700 (Carl Zeiss Meditec, Jena, Germany) were 22.65 mm and 22.54 mm for right and left eye, respectively. AcrySof IQ PanOptix TFNT00 intraocular lenses (Alcon, Fort Worth, USA) were implanted in both eyes with labeled far power of +24.0 D and +24.5 D for the right and the left eye, respectively.

The TFNT00 is a single-piece diffractive aspheric intraocular lens. Using the second and third diffraction orders two additional foci are created, an intermediate addition of +2.17 D and a near addition of +3.25 D.[14] Due to the non-apodized profile the light distribution to the different foci is independent from pupil size.[15] The overall diameter of the IOL is 13.0 mm and the optic zone's diameter is 6.0 mm. The diffractive part of the optic is 4.5 mm with 15 diffractive rings. The acrylate/methacrylate copolymer includes an ultraviolet and blue light filter.

Keratometry (IOLMaster 700, Zeiss, Oberkochen, Germany) revealed a corneal astigmatism of −1.22 @ 6 for the right and −1.14 @ 178 for the left eye (Table 1). The regular with-the-rule astigmatism was confirmed by the Pentacam HR tomography (Oculus GmbH, Wetzlar, Germany). To reduce astigmatism, surgery was performed from a 12 o'clock position and an opposite clear corneal incision (OCCI) was created. In order to avoid inducing corneal irregularities we did not suture the wounds but created self-sealing, watertight incisions that were observed continually in the postoperative period. The postoperative course was without any complications. Visual acuity was evaluated 3-months postoperatively in different distances (Table 2). Additionally, a defocus curve was performed (Fig. 1). A questionnaire revealed good satisfaction and spectacle independence of the young patient. The boy did not report disturbing photic phenomena. A computer-based simulator (Halo and Glare Simulator, Eyeland Design Network GmbH, Vreden, Germany) confirmed low photic phenomena (Fig. 2).

Table 1
Pre- and post-operative keratometric data.

Eye	R1 (mm/°)		R2 (mm/°)		Cylinder (D/°)		Reduction in Cylinder (D)
	pre	post	pre	post	pre	post	
Right	7.81 @ 6	7.76 @ 179	7.59 @ 96	7.66 @ 89	−1.22 @ 6	−0.57 @ 179	0.65
Left	7.78 @ 178	7.77 @ 2	7.58 @ 88	7.63 @ 92	−1.14 @ 178	−0.76 @ 2	0.38

R: corneal radius, pre: preoperative value, post: 3-month postoperative value.

Table 2
Visual acuity and manifest refraction at 3-months postoperative visit [in logMAR].

	Right Eye	Left Eye
UDVA	0.00	0.04
Binocular UDVA	−0.06	
Manifest refraction	+0.25–0.25 × 10	0.00–0.75 × 10
CDVA	−0.06	−0.04
Binocular CDVA	−0.1	
UIVA (60 cm)	0.04	−0.06
Binocular UIVA (60 cm)	−0.04	
UNVA (40cm)	0.14	0.12
Binocular UNVA (40cm)	0.02	

UDVA: uncorrected distance visual acuity, CDVA: corrected distance visual acuity, UIVA: uncorrected intermediate visual acuity, UNVA: uncorrected near visual acuity.

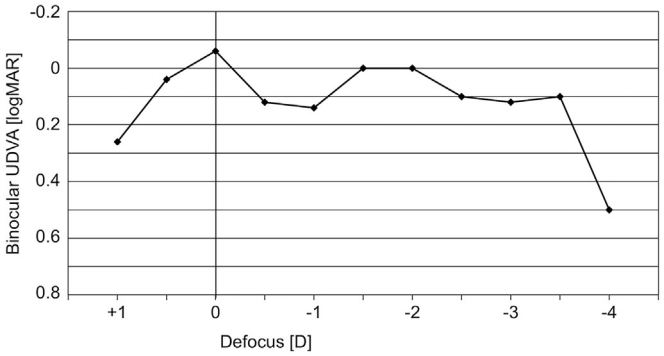

Fig. 1. Binocular uncorrected defocus curve (4 m distance) at 3-months postoperative visit.

3. Discussion

In this case of a young patient with bilateral steroid-induced cataract after acute lymphoblastic leukemia treatment, restoration of visual acuity could be achieved for far, intermediate and near distance. To our knowledge this is the first described case of bilateral trifocal IOL implantation in a child. Implantation of monofocal intraocular lenses would have resulted in the need for spectacles for near and intermediate distance due to the loss of accommodation. It is well known that MIOLs provide good visual acuity for far and near distance.[16] Trifocal lenses also create an intermediate focus and show good clinical results in adults.[8] In a recent study 27 patients were implanted bilaterally with PanOptix IOLs (Alcon, Fort Worth, USA). Binocular UDVA, binocular UIVA and binocular UNVA were 0.00 ± 0.094 logMAR, 0.00 ± 0.111 logMAR, and 0.01 ± 0.087 logMAR, respectively.[8]

Ram et al. compared monofocal with multifocal IOL implantation in children with bilateral cataract.[4] The authors implanted two different multifocal lenses, the AcrySof IQ Restor SN6AD1 (Alcon, Fort Worth, USA) with a +3 D near addition and the Preziol (Care Group, Baroda, India) with a +4 D near addition. The authors compared the results of corrected distance visual acuity (CDVA), distance corrected near visual acuity (DCNVA), contrast sensitivity and stereopsis with the results of three different monofocal lenses. Additionally, complications like posterior capsule opacification, IOL tilt and decentration were assessed. Results for CDVA were comparable for both groups while DCNVA showed statistically significant better results in the multifocal group without decrease in contrast sensitivity.[4] A retrospective study that included 34 pediatric cataract eyes from patients aged 2–15 years evaluated the AcrySof IQ Restor SN6AD3 (Alcon Labs Inc., Fort Worth, USA) with a +4 D near addition. Patients yielded good results for

Fig. 2. Results of the Halo and Glare simulation at 3-months postoperative visit.

distance and near vision and improvement in stereopsis with low complication rates.[17] In both studies the authors concluded that the implantation of MIOLs is a viable alternative to monofocal IOL implantation in pediatric cataract cases.[4,17]

Due to separation of the incoming light to more than one focus, reduction in contrast sensitivity might be a disadvantage of diffractive multifocal optics that should be explained to the patient. Some studies show reduced contrast sensitivity values in early refractive and diffractive multifocal intraocular lenses when compared to monofocal IOLs.[11,12] A prospective randomized comparative study by Sen et al. including 54 eyes with multifocal (Array SA40 N, AMO) and 67 with monofocal (SI-40NB, AMO) intraocular lenses found slightly lower contrast sensitivity values in the multifocal group.[12] Nevertheless, a systematic Cochrane review could not show a statistically significant reduction in contrast sensitivity in MIOLs compared to monofocal IOLs.[18] MIOLs are known to have a higher chance of developing photic phenomena like halos and glare compared to monofocal lenses.[18] Nevertheless, neuroadaptation plays an important role in reducing photic phenomena over time.[19] Children are thought to have a plastic neurosystem, so it is possible that younger patients might cope better with the different retinal images compared to adults.

When implanting MIOLs the surgeon has to consider that a non-ideal outcome, such as a post-operative lens decentration, has a greater deleterious impact with a MIOL than if the lens were a monofocal.[26] Laboratory studies demonstrated that optical quality is significantly reduced if decentration occurs in multifocal lenses.[20] The child from this report had perfectly healthy eyes apart from the cataract without expected amblyopia and also showed no suspicious biometry data and no expected complicating factors.

There is no report in the literature on trifocal IOL implantation in pediatric cataract cases. The experience in adult patients suggests that trifocal IOLs produce results for far and near visual acuity similar to bifocal IOLs but the trifocal give an additional intermediate focus point.[21] There are several different trifocal IOL models available for implantation. In previous laboratory studies we compared the optical quality of three different trifocal IOLs, the FineVision Micro F (PhysIOL, Liège, Belgium), the AT Lisa tri 839MP (Carl Zeiss Meditec, Oberkochen, Germany) and the PanOptix TFNT00 (Alcon, Fort Worth, USA).[15] All three IOLs yielded good optical quality results by means of modulation transfer function and showed three distinct foci in the through focus scan for far, intermediate and near focus. Thus, optical quality did not favor any one of the trifocal models.

Vasavada has reported his experience with pediatric cataract surgery.[9,22] In one of his studies, including 103 eyes of 72 children with congenital cataract, results show that the AcrySof IOL material has a good biocompatibility with rather low rates of PCO.[9]

It is well known that pupil diameter is age-dependent and the fluctuation range of pupil diameter is higher in younger patients.[1] Heine et al. found that the mesopic pupil size decreased by 0.42 mm per decade in a population of 206 volunteers aged between 18 and 72 years without disorders influencing the pupil.[10] Unlike the well-known bifocal Restor IOL (Alcon, Fort Worth, USA), which shares the same AcrySof IQ platform, the design of the PanOptix does not feature apodization; a varying step height of the diffractive rings with the pupil size. The absence of apodization ensures that the light energy allocation to the three foci is independent of the pupil. In vitro imaging and modulation transfer function measurements using different aperture sizes have confirmed that the light distribution of the PanOptix does not depend much on the pupil diameter as compared to other multifocal IOLs.[15,23] Thus, even in a young patient's larger pupil the intermediate and near focus can be used. Because of the long experience with the AcrySof IOL material and the independence from pupil size we chose a PanOptix IOL for this patient.

Recent studies suggest that toric IOLs are more effective in correcting corneal astigmatism than incisional techniques.[24] There is one case report of a 6-year old child treated with a toric AcrySof IQ ReSTOR IOL that resulted in excellent visual acuity for far and near distance.[25] The child had a corneal astigmatism of −2.13 D @ 174. In our case the corneal astigmatism was lower (−1.22 @ 6° and −1.14 @ 178). We used the Barrett Toric Algorithm to calculate a possible toric version of the IOL preoperatively. Calculations showed that the lowest toric version available (1.0 D cylinder) would not have resulted in a benefit regarding the postoperative cylinder. Thus, we decided to perform surgery from a 12 o'clock position and create an OCCI in both eyes to reduce the astigmatism as much as possible (Table 1).

4. Conclusion

In this case, binocular implantation of trifocal IOLs provided an effective way to restore the visual function and lead to sufficient creation of pseudo-accommodation in this pediatric cataract case. It resulted in good visual acuity for far, intermediate and near distance with high patient satisfaction. Trifocal IOL implantation should be considered as an alternative to monofocal lenses in selected cases of pediatric cataract where amblyopia is not expected. Risks and benefits have to be discussed in detail with the patient and the parents.

Patient consent statement

Patient consent to publish this case report was not obtained. This report does not contain any information that could lead to identification of the patient. Retrospective review of this case was done in accordance with the Declaration of Helsinki.

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Conflicts of interest

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

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