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Visual and Functional Outcome of Pediatric Bilateral Cataract Surgery with Intraocular Lens Implantation in Rwanda

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Abstract

Objectives: To evaluate visual and functional outcome of bilateral pediatric cataract surgery with intraocular lens implantation in Kabgayi Eye Unit, Rwanda.

Methods: Surgical, pre-, and postoperative data of bilateral pediatric cataract surgery cases performed between 1999 and 2007 were collected from the notes. During a prospective follow-up visit in 2008 full eye examination was done, including best corrected visual acuity (BCVA) assessment and refraction. Functional vision in daily life was assessed using a questionnaire.

Results: The follow-up examination was attended by 108 children (56.5% girls, participation rate 87.8%). Mean age at the time of surgery was 6.6 years (SD 4.6, range 0-19). Cataract was noticed ≤ 3 months in 83.7% (n = 77). Mean delay between start of symptoms and operation date was 4.9 years (SD 4.0, range 0-16 years). Preoperative blindness was present in 79.1% of children (n = 68). Posterior capsulotomy and vitrectomy were performed in 161 eyes (83.9%). At the study visit (mean follow-up 33.6 months, SD 15.9) 33 children (35.1%) had BCVA ≥ 6/18 in their best eye and 13 remained blind (13.8%). Spherical equivalent ≤ 2 D was present in 42.6% and astigmatism ≤ 2 D in 80.5% (n = 157). Functionally, vision was normal or nearly normal in 76 children (71.7%) and severe low vision and blindness remained in 2 children each (1.9%).

Conclusion: Bilateral pediatric cataract surgery can offer good functional results, even if BCVA does not improve to the same extent. Orthoptic and low vision facilities with efficient community liaison are recommended.

Keywords

Pediatric cataract surgery, Africa, Functional outcome, Visual outcome

Introduction

The control of childhood blindness has been identified as a priority of the WHO global initiative for the elimination of avoidable blindness by the year 2020. About 350,000 children become blind each year [1]. The estimated number of blind children worldwide have reduced from 1.4 million in 1999 to 1.26 million in 2010 thanks to public health interventions like better measles immunisation and vitamin A supplementation [2]. However, in Sub-Saharan Africa childhood blindness has increased by 31%, partly because of an increase in the child population [2]. Cataract has now become the leading cause of avoidable childhood blindness worldwide [3].

The management of childhood cataract is more difficult than that of adult cataract for various reasons. Since this cataract type involves growing eyes, early cataract operation and regular update in refraction during the years following surgery are desirable to avoid amblyopia. Furthermore, in developing countries, there is often a delay in presentation for surgery, and the follow-up of those children after surgery to improve compliance to refractive correction has proven to be difficult [4-9]. In the eye department of the Kabgayi Hospital, one of the leading eye units in Rwanda, pediatric cataract surgery was occasionally performed without vitrectomy equipment from 1999 onwards. It is only since 2003 with the arrival of essential vitrectomy equipment and know-how, that pediatric cataract surgery was frequently performed. Full biometry, including handheld automated keratometry, was available only after 2006. Historically, less than half of the operated children came back for regular follow-up despite providing eye care and glasses free of charge and reimbursement of transport.

The primary aims of this study were to evaluate the visual outcome of bilateral pediatric cataract surgery with intraocular lens (IOL) insertion in Kabgayi and the impact this had on the daily life of these operated children. Secondary objectives were to identify the frequency of complications, to measure the degree of postoperative refractive errors and to estimate the need for low vision facilities and special education in this group of children in Rwanda.

Patients and Methods

Inclusion criteria

This retrospective mono-centre case series investigated the visual

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outcome of bilateral pediatric cataract surgery with IOL insertion by chart review and a follow-up examination organised in 2008. The eligible children had at least one eye cataract operation done in the Kabgayi Eye Unit between 1999 and 2007. The cataract operations took place at the age ranging from 0 to 19 years and all participants lived in Rwanda. Children developing bilateral cataracts before the age of 21 were considered, but cataracts from traumatic or uveitic origin were excluded.

Chart review

During the chart review basic demographic, surgical, pre-, and postoperative data were collected. Only a minority of patients had biometry done before the cataract operation, mainly because of repeated technical failure. Three different A-scans were used over the years (Nidek US-1800 Echoscan, Japan, Autoscan DB-3000C Ocuserv Instruments, Jamaica and Ultrasonic A-scan DGH Technology, USA).

Follow-up examination

The eligible children and their families were recalled for repeat clinical examination in 2008 via public announcements or contacted by a social worker and requested to attend a free follow-up examination in Kabgayi Eye Unit.

Functional vision assessment: During the follow-up visit, the effect of impaired vision on daily activities was evaluated using the questionnaire for functional vision assessment developed by Hyvarinen (Cracow-ICEVI 2000) and adapted to the local habits (Table 1). This questionnaire assesses the effect of visual impairment in four main areas (social behaviour and communication, orientation and mobility, activities of daily life and sustained near vision tasks). In each of these four areas a person uses either techniques typical to sighted people (obtaining 1 point), typical to persons with low vision (2 points) or typical to the blind (3 points). Summing up the points for all 4 areas, resulted in one overall score (varying from 4 to 12), depicting the overall functional abilities. In case one of the areas was not applicable, the overall score was obtained by extrapolation. This functional ability score classifies the children as functionally normal sighted (score 4) or near normal sighted (score 5), mild (score 6-7), moderate (score 8-9) or severe low sighted (score 10-11) or functionally blind (score 12). A score 4 or 5 was considered as a good functional ability result. This multiple-choice questionnaire was taken by trained eye unit staff in the local language and answered by parent and child together, prior to the visual acuity assessment.

Visual acuity assessment: Subsequently, presenting visual acuity and best corrected visual acuity (BCVA) were measured by one and the same trained low vision therapist, invited from Kenya

Table 1: Questionnaire for functional vision assessment in 4 main domains developed by Hyvarinen and adapted to the local habits, classifying the children as functionally sighted, low sighted or blind.

Main domains	Behaves like sighted	Behaves like low vision	Behaves like blind
Social behaviour & communication			
Can the child see a face those smiles at a normal distance?	Yes	Difficult, squeezes	No
Does the child lip-read (in case he is deaf)?	Yes lip reads	Difficult, squeezes	Cannot see the lips move
Can the child see hands indicating to come nearby?	Yes	Difficult, squeezes	No
Does the child recognize father, mother, friends, even without hearing their voice?	Yes	Difficult, squeezes	No
Does the child talk to father, mother, brothers or sisters?	Yes, possible, like any other child	Less than other children	Rarely or never because he cannot see where they are
Does the child talk to friends?	Yes, possible, like any other child	Less than other children	Rarely or never because he cannot see where they are
Does the child talk to several friends together in a group?	Yes, possible, like any other child	Less than other children	Rarely or never because he cannot see where they are
Orientation & mobility			
Can the child move around alone in the house?	Yes, he easily finds his way	He walks slowly but finds his bed and the table	No, he cannot find his bed, nor the table on his own
Can the child move alone on the compound (eg. towards the toilet in case it is outside the house)?	Yes, he easily finds his way	He walks slowly but finds the way to the toilet	No, he cannot find his way to the toilet on his own
Can the child move alone in the village where he lives?	Yes, he easily finds his way to other houses	He walks slowly but finds the way to other houses	No, he cannot find his way to other houses on his own
Does the child go out to draw water?	Yes, he often leaves home out for water or other reasons	He walks slowly but finds the way to the water	No, he would fall or lose his way
Did your child visit friends in other villages or towns?	Yes, no problem to visit friends in another village	he needs some help to travel but it is possible	No, he never leaves our village, because he cannot see
Does the child play football, sports, music?	Yes, no problem	Yes, but it is difficult	No because he cannot see enough
Daily activities			
Can the child wash himself on his own?	Yes, no problem	Yes, but only if water and soap are given to him right away.	No, he needs help
Can the child look after his younger brothers or sisters?	Yes, no problem	Yes, but it is more difficult than for other children of his age	No, because he cannot see
Can the child eat without help from another person?	Yes, he eats like other children of his age	Yes, he eats without help, but more difficult than other children of his age	No, he needs more help than other children of his age
Does the child help cleaning the house?	Yes, like other children of his age	Yes, but more difficult than other children of his age	No, he cannot do the same as other children of his age
Can the child get dressed on his own?	Yes, like other children of his age	Yes, but only if his clothes are given to him right away.	No, he cannot do the same as other children of his age
Sustained near vision tasks			
Can the child read and write at school?	Yes, like other children of his age	Yes, but more difficult than other children of his age	No, he cannot do the same as other children of his age
Can the child sort beans or rice, or peel potatoes?	Yes, like other children of his age	Yes, but more difficult than other children of his age	No, he cannot do the same as other children of his age
Can the child play with marbles with his friends?	Yes, like other children of his age	Yes, but more difficult than other children of his age	No, he cannot do the same as other children of his age

during 3 campaign weeks. A variety of age-appropriate detection and recognition visual acuity techniques were used, including Cardiff cards, Lea tests and Snellen charts. In children who could not cooperate, semi-quantitative visual acuity estimates were used. Classification of the presenting visual acuity and BCVA in normally sighted, low vision, severe low vision or blindness, as used by the World Health Organization (WHO) was applied according to the children's best eye [10]. This was defined as the eye with the better BCVA at the time of the follow-up examination. A BCVA of 6/18 or better was considered as a good BCVA outcome. The degree of astigmatism and refractive error were documented by an objective and subjective refraction, and completed with a low vision assessment if indicated, all performed by the low vision expert.

Eye assessment and biometry: Biomicroscopy, intraocular pressure (IOP) and eye fundus examination were done by the ophthalmic clinical officer or an ophthalmologist (PN or SDS). A trained eye nurse measured the axial length (Nidek US-1800 Echoscan, Japan) and keratometry values (automated portable keratometer Nidek KM-500, Japan).

Ethics: Informed consent was obtained. Participating children and their guardians were reimbursed their transport during the study days and in case accommodation, eye medication, spectacles or low vision devices were necessary, the children received these for free. This study was conducted in accordance with the Declaration of Helsinki and approved by the Rwandan National Ethics Committee.

Analysis: Data were entered in a Microsoft Access database. STATA-software was used to analyze the data.

Results

Participation rate

Of the 127 children fulfilling the inclusion criteria, 108 children participated, 15 could not be found (no refusals) and 4 had passed away, resulting in a participation rate of 87.8% (108/123). Of the 108 children included in this study, 3 presented with the first eye already in phthisis at the time of initial presentation before any surgery in Kabgayi. We do not have any information on the surgical history elsewhere of these phthisic eyes.

Baseline characteristics of the children

There were 47 boys (43.5%) and 61 girls (56.5%). The gender distribution was not significantly different among participating and missing children (P = 0.232). In 77 out of 92 children (83.7%, 16 missing data) the eye problem was noticed by the family before or at the age of 3 months without any significant gender effect (P = 0.757). The mean age at cataract operation of the best eye was 6.6 years (SD 4.6, range 3 months-19 years, 4 missing data) without significant gender effect (P = 0.313), with the following age subgroup distribution: 0-1 year 25 children (24%), 2-6 year n = 29, (27.9%), 7-10 year n = 31, (29.8%), 11-15 year n = 14, (13.5%) and 16-19 year n = 5, (4.8%). The mean delay between start of symptoms and the operation date of the best eye was 4.9 years (SD 4.0, range 0-16 years) without significant gender effect (P = 0.079).

Preoperative data

Of the 216 operated eyes 92 eyes (61.7%) had a complete cataract. Fourteen eyes (6.7%) presented with associated ocular co-pathologies: 11 eyes had microphthalmos/ coloboma, 2 eyes with corneal pathologies (keratoconus, opacity) and 1 eye with glaucoma. Nystagmus and squint were present in 49 (53.8%, 17 missing data) and 41 children (50%, 26 missing data) respectively. Associated systemic pathologies were present in 9 children (11.8%, 32 missing data) and 1 child had a hearing deficiency (1.4%, 35 missing data). Table 2 shows the preoperative biometry, intraocular pressure and power of the inserted IOL. In only 52 eyes (24.1%) A-scan biometry was done before the operation.

Operative and postoperative data

Table 3 represents the operative details and complications of the pediatric cataract surgery performed, as mentioned in the notes. Surgery had been carried out by 8 different surgeons. All eyes received IOL at the time of operation. In the majority of eyes removal of the posterior capsule and the anterior central vitreous was performed either via limbal or pars plana access, but in 12% eyes (24 missing data) the posterior capsule remained intact during the initial surgery. Late complications as mentioned in the notes happened in 50 eyes (24.5%, 12 missing data) with posterior capsule opacification (PCO) as the most frequent complication.

Follow-up duration

The mean follow-up time from the time of the operation till the time of this study was 32.1 months (11 missing data). Considering the best eyes separately, this follow-up was 33.6 months (SD 15.9, range 3-100 months, 4 missing data). Ninety six children (92.3%, 4 missing data) had a follow-up time of one year or over for their best eye. The mean age at the time of the follow-up examination was 9.6 years (SD 4.9, range 2- 21).

Visual acuity at the follow-up examination

Ten children (9.3%) were not cooperative for visual acuity assessment, and 4 (3.7%) were absent on the days the low vision therapist was taking BCVA. From the remaining 94 children, the tests used for measuring the postoperative BCVA were Lea numbers in 28 cases (29.8%), Cardiff pictures in 29 (30.9%), Lea symbols in 28 (29.8%), and counting fingers/hand movements in 9 (9.6%). At the follow-up examination spectacles were worn by only 4 children (3.9%, 5 missing data). Table 4 shows the presenting visual acuity and BCVA for the best eye during the follow-up examination, expressed in the WHO-classification. A BCVA of 6/18 or better was measured in 33/94 children (35.1%) and 13/94 children (13.8%) remained blind. All 13 were blind preoperatively, only two had postoperative complications (one PCO, one with corneal opacification) but 12 were operated after the age of 6. When considering all eyes (n = 188), 40 (21.3%) had 6/18 or better BCVA and 54 (28.7%) remained blind.

Functional vision score at the follow-up examination

Table 5 represents the children's functional ability score. Seventy

Table 2: Pre-and postoperative biometry and intraocular pressure (IOP), intraocular lens (IOL) power and postoperative refraction of all 216 operated eyes.

	Preoperative					At follow-up examination				
	Mean	SD	Min	Max	Missing data	Mean	SD	Min	Max	Missing data
Axial length (mm)	22.4	1.7	18.4	26.1	164	22.1	1.8	16.9	27.5	12
K1-readings (diopter)	42.9	1.8	37.5	46.3	154	43.5	2.7	36.8	53.0	11
K2- readings (diopter)	44.3	2.1	39.0	48.8	154	45.5	3.0	39.8	57.5	11
mean K-readings (diopter)	43.6	1.9	39.3	47.5	154	44.5	2.8	39.3	54.8	11
IOP (mmHg)	16.3	6.0	8.0	30.0	193	14.2	3.6	7.0	30.0	8
Power IOL inserted (diopter) (total group)	23.9	3.4	13.0	30.0	13					
Subgroup where biometry done preoperatively	24.0	3.7	15.0	30.0						
Subgroup where biometry not done preoperatively	23.8	3.6	14.0	30.0						
Objective sphere used (diopter)						-1.7	3.9	-12.0	13.0	21
Objective cylinder used (diopter)						-1.3	1.4	-6.0	0.0	21
Objective spherical equivalent (diopter)						-2.3	4.0	-15.0	12.5	21

Table 3: Operative details and complications of all operated eyes (n = 216) as mentioned in the notes.

	Number	%	Missing data
Intraocular lens (IOL) position			78
IOL in the bag	74	53.6	
IOL in the sulcus	31	22.5	
IOL haptics in sulcus, optic in bag	25	18.1	
IOL haptics in bag and optic behind posterior capsule	7	5.1	
Anterior chambre IOL	1	0.7	
Vitrectomy done			24
Yes, via limbal access	80	41.7	
Yes, via pars plana access	81	42.2	
No, posterior capsule intact	23	12.0	
No, only needle capsulotomy	8	4.2	
Number of eyes with early complications (within 1 week)	41	19.9	10
Inflammation	29		
Corneal oedema	1		
Posterior/anterior capsule opacification	4		
Hyphema/ vitreous haemorrhage	2		
IOL displaced	6		
Number of eyes with late complications (after more than 1 week)	50	24.5	12
Inflammation	7		
Corneal oedema	1		
Posterior capsule opacification	35		
Posterior synechiae/ iriscapture	8		
IOL displaced	3		
Number of eyes with reintervention done	42	21.3	19
YAG capsulotomy	13		
Surgical removal of visual axis opacification	20		
Repositioning IOL	10		
Exchange IOL	1		

Table 4: The WHO classification of the visual acuity for the 108 operated children's best eyes with IOL, measured preoperatively and postoperatively (presenting vision during the study and best corrected visual acuity BCVA).

	Preoperatively*		At the study time** (presenting vision)		At the study time** (BCVA)	
	Number	%	Number	%	Number	%
≥ 6/18	1	1.2	12	12.8	33	35.1
< 6/18 - 6/60	6	7.0	54	57.5	42	44.7
< 6/60 - 3/60	11	12.8	10	10.6	6	6.4
< 3/60	68	79.1	18	19.2	13	13.8

Missing data *22, **14.

Table 5: The number of children classified according to their functional score by 4 main domains and in total, as obtained during the functional questionnaire.

Specific areas	Social behaviour & communication		Orientation & mobility		Daily activities*		Sustained near vision tasks*		Total functional ability score**	
	Number	%	Number	%	Number	%	Number	%	Number	%
Normally sighted (score 4)	68	63.0	71	70.3	67	68.4	48	54.6	57	53.8
Near normally sighted (score 5)	23	21.3	12	11.9	7	7.1	5	5.7	19	17.9
Mild low sighted (score 6)	9	8.3	5	5.0	18	18.4	4	4.6	16	15.1
Moderate low sighted (score 8)	5	4.6	9	8.9	3	3.1	19	21.6	10	9.4
Severe low sighted (score 10)	1	0.9	2	2.0	2	2.0	4	4.6	2	1.9
Blind (score 12)	2	1.9	2	2.0	1	1.0	8	9.1	2	1.9
Section not applicable			7		9		19			

Missing data *1, **2.

Table 6: The distribution of WHO classification of the presenting visual acuity for the 108 operated childrens' best eyes with intraocular lens, by total functional ability score.

	Total functional ability score**					
WHO*	Normally/nearly normally sighted		Mild to moderate low sighted		Severe low sighted	
	Number	%	Number	%	Number	%
6/18 or more	10.0	14.9	2.0	8.3	0.0	
< 6/18 - 6/60	40.0	59.7	12.0	50.0	0.0	
< 6/60 - 3/60	9.0	13.4	1.0	4.2	0.0	
< 3/60	8.0	11.9	9.0	37.5	1.0	100.0
Total	67	100	24	100	1	100

Missing data *14, **2.

six children (71.7%) were functional normally or near normally sighted. Functionally mild or moderate low vision was present in 26 children (24.5%), severe low vision and blindness remained in 2 children each (1.9%). Table 6 plots the results of functional vision categories against the presenting visual acuity of the best eyes documented during the follow-up visit. The functional ability score tended to be correlated with WHO-classification of the presenting visual acuities (P = 0.055).

Plotting the 4 functional scores individually against the presenting visual acuity of the best eyes revealed no statistical significant association, except for sustained near vision tasks (P = 0.02). Of the 10 non cooperative children during formal VA tests, 50% were functional normally or near normally sighted (n = 5), 20% functional mild to moderately low sighted (n = 2), 1 child severely low sighted (10%) and 20% were functionally blind (n = 2). The functional ability score was significantly worse for those children compared to cooperative children (P = 0.046).

Ophthalmic findings during the follow-up examination

Table 7 shows ophthalmologic findings at slit lamp examination and fundoscopy during the follow-up examination. Table 2 shows the postoperative biometry, IOP and objective refraction in all operated eyes at the time of the follow-up examination. An axial length of 25 mm or more was present in 10 eyes (4.9%). Eighty three eyes (42.6%) had a spherical equivalent within +/- 2 D and 157 (80.5%) astigmatism within 2D. The mean IOP was 14.2 mmHg (SD 3.6, range 7-30) with 5 eyes (4 patients) above 21 mmHg. An IOP of at least 25mmHg was measured in 4 eyes (1.9%, 3 patients). Of these 5 eyes IOP was measured under general anaesthesia in 4 eyes, 3 eyes of which immediately after induction. In all those 5 eyes a posterior IOL was inserted and an anterior vitrectomy via pars plana approach done. The IOP before the cataract intervention was known in only one of these eyes, which was normal. One child was younger than 1 year and 2 children were 1-year-old at the time of the operation. Typical glaucomatous optic disc changes were not noted during the follow-up examination in these eyes.

Posterior capsule opacification rate

Counting all eyes with PCO (the ones mentioned in the notes and the new ones noticed during the study) resulted in 45/216 eyes (20.8%) that suffered from PCO at any stage. The prevalence of PCO in the group with posterior capsule left intact during the initial operation was 82.6% (19/23). Performing a primary needle capsulotomy did not make a significant difference in PCO-prevalence (75%, 6/8, P = 0.644), whereas a primary anterior vitrectomy via limbal or pars plana approach did reduce this prevalence significantly to 9.9% (16/161 eyes, OR 0.03, CI 0.01 -0.10, P < 0.001). In 4 PCO cases the use of initial capsulotomy was not specified in the notes. The PCO-rate was not significantly influenced by a follow-up of 12 months or more (P = 0.575), even after correction for the initial capsulotomy technique used. PCO reoccurred in 22 (13.0%) of all 169 eyes documented to have undergone primary needle or vitrector capsulotomy and in 4 eyes (2.4%) even after an initial anterior vitrectomy and a secondary capsulotomy, which was done by vitrectomy in 3 out of 4 eyes.

Table 7: Ophthalmic findings of all eyes during the follow-up examination (n = 216).

	Number	%	Missing data
Posterior capsule opacification	20	9.4	3
IOL (intraocular lens) dislocated but still in visual axis	10	4.7	3
Central corneal opacification	7	3.3	2
Depositions covering the whole IOL	4	1.9	3
Macular scar	3	1.4	6
Anterior chamber cells	2	0.9	5
Squint	122	61.0	16
Nystagmus	76	38.0	16
Phthisis	3	1.4	0

Analysis of potential predictors for good outcome

The univariable analysis of the effect of potential confounding factors on visual outcome (BCVA) of the best eye during the study (Table 8) identified preoperative presence of blindness (P < 0.001), preoperative nystagmus (P < 0.001) and the early age (< 3 months) of cataract onset (P = 0.003) as significant predictors for poor outcome. Of children without preoperative blindness 76.5% became normally sighted. The presence of PCO or other complications did not influence the visual outcome significantly, provided these were treated. Univariable analysis (Table 8) showed that children with preoperative presence of nystagmus (P < 0.001) and early age of cataract onset (P = 0.02) were nearly 6 and 4 times less likely respectively to get a good functional ability score after surgery.

Education and optical aids

Among the children at school age, 56 (73.7%) went to a normal school and 8 (10.5%) to a special school at the time of the follow visit. Of those children at school age, 8 (10.5%) were studying in at least 4th primary school year, and 2 (2.6%) even in secondary school. None used low vision devices since there was no service in place prescribing, issuing and managing them.

After the follow-up examination 77 (74.0%, 4 missing children) children got glasses prescribed (59 bifocals and 18 single vision) and 8 (7.7%) were given low vision devices. In 56 (53.9%) cases a low vision assessment at a later stage was planned, after a trial with bifocals. Special treatment (Braille, deaf or cerebral palsy special schools) were recommended for 17 patients (16.3%), of which only 6 were already benefiting from such facilities.

Discussion

Paediatric cataract has become one of the most important causes of avoidable blindness in children in developing countries as a result of better control of conditions leading to corneal scarring [3]. It presents an enormous problem to the developing world in terms of human morbidity, economic loss, and social burden, compared to elderly patients with age related cataract [11]. This monocenter study evaluated the visual and functional long term results of bilateral pediatric cataract surgeries with IOL in Rwanda with a good participation rate.

Mean age at the time of cataract surgery was 6.6 years, which is higher than what is typically reported from developing world. Median age at surgery was reported as 7 years in a study from Lahan, Nepal

Table 8: The influence of factors (odds ratio OR) on good outcome in best eye's best corrected visual acuity (BCVA) and on an optimal score at the functional questionnaire during the study.

	Effect on optimal score for best eye's BCVA					Effect on optimal score on the functional questionnaire				
	OR	P-value	95% confidence interval			OR	P-value	95% confidence interval		
Cataracts early discovered (in the first 3 months of life)	**0.24**	**0.003**	**0.08**		**0.67**	**0.27**	**0.02**	**0.08**		**0.92**
Preoperative nystagmus	**0.15**	**0.000**	**0.04**	-	**0.48**	**0.17**	**0.002**	**0.05**	-	**0.60**
Preoperative blindness	**0.11**	**0.000**	**0.03**	-	**0.44**	0.51	0.318	0.13	-	1.98
Male gender	1.2	0.677	0.51		2.83	1	0.994	0.43		2.36
Operated within 1 year	1.45	0.539	0.44	-	4.79	0.53	0.209	0.19	-	1.46
Early complications	0.77	0.667	0.24	-	2.49	1.55	0.473	0.46	-	5.21
Late complications	0.84	0.770	0.26	-	2.73	2.30	0.209	0.60	-	8.75
Follow-up of 1 year or more	0.98	0.445	0.94	-	1.03	1.01	0.512	0.97	-	1.06
Operation in 2006 or later	2.00	0.141	0.78	-	5.11	1.16	0.748	0.47	-	2.88
Aged ≤ 2 years at the operation	0.67	0.493	0.21	-	2.12	0.73	0.516	0.28	-	1.90
Initial vitrectomy	0.71	0.569	0.22	-	2.31	0.16	0.055	0.02	-	1.37
Posterior capsule opaque	1.43	0.657	0.30	-	6.86	2.88	0.315	0.33	-	25.04
IOL (intraocular lens) in bag position	1.65	0.366	0.55	-	4.94	1.26	0.668	0.44	-	3.58

[12]. However, in that study the authors contributed it to delayed presentation and lack of awareness among primary healthcare workers and general physicians of the importance of early surgery. In current series, age at diagnosis of cataract was early (≤ 3 months in 83.7%) Mean delay between start of symptoms and operation date was 4.9 years. Children awaiting surgery in Rwanda where the operation technique became available only since 2003 can explain delay in surgery.

In contrast to the current study, studies from other African regions found a significant gender difference in number of participants receiving surgery [4] and in delay of surgery in favour of boys [3,5]. Results of Lahan, Nepal also showed that 74% of the subjects were boys [12]. Even missing data could not explain this difference in our series, indicating different societal expectations of gender roles in Rwanda.

One third of children achieved good visual outcome after surgery in their better eye in our study, which is in line with a recent study from Bangladesh [13] and Zambia [14], but lower than the results in a study from Dar-es-Salaam (62%) [5]. A lower percentage of preoperative blindness (65% in Dar-es-Salaam) and a shorter delay between parents first noting a problem and surgery can partly explain this difference (on average 14 months less in Dar-es-Salaam) [5].

Considering all operated eyes, a study from Kenya found better visual results with 44% of eyes achieving at least 6/18 [4]. That study had similar prevalence of preoperative blindness, but less complete cataracts, less patients operated on both eyes and far lower age at operation (3.5 year) than ours. The effect of a backlog of children awaiting surgery in Rwanda where that operation technique became available only since 2003, could partly explain this difference. Our higher participation rate, longer follow-up and lower missing data rate could also contribute to a more realistic picture.

Nevertheless the main challenge for improving visual outcome after pediatric cataract surgery is tackling amblyopia. Like in other parts of Africa results can be improved by setting up a solid community based rehabilitation (CBR) program allowing for early identification [15]. This network of community-based social workers can also ensure school support to improve compliance to refractive correction and amblyopia treatment after pediatric cataract surgery.

The provision of glasses after the follow-up examination enabled a considerable number of children to shift from low vision to normally sight. Because late presentation adversely affects the visual outcome, it is important that providers of surgical services for cataracts in children also provide low-vision services so that the children's residual vision can be maximized.

Although spherical equivalent ≤ 2 D was present in 42.6% cases, range of spherical equivalent was wide (-12 to +13) which is not surprising. However, spectacles were worn by only 4 children (3.9%), which further suggest importance of regular follow-up examination.

Functional visual assessment

The functional outcome of bilateral pediatric cataract surgery has never been evaluated in Africa before. Although the overall score of the functional ability questionnaire tended to follow the distribution of the presenting visual acuity well, it estimated the outcome more optimistically than the formal visual acuity. Similar risk factors for poor outcome were identified for both assessment methods. The percentage of children at school age going to normal schools was similar to the percentage children scoring well on the functional questionnaire. In case formal visual acuity testing was not feasible, the functional visual assessment managed to give an idea on the functional ability, and the ability rating was generally lower than in cooperative participants. Sustained near vision tasks were stronger correlated to uncorrected presenting visual acuity than the other functional parameters. This discrepancy suggests that the restauration of the children‘s visual fields after cataract surgery is more important for orientation and mobility in daily life than visual acuity, which remains critical for near vision tasks. The functional visual assessment is useful and reliable and cataract surgery in blind children can offer good functional results in daily life, even if the BCVA does not improve to the same extent.

Complications

The complication rate and residual refractive error of the operations performed in Kabgayi were in line with other studies [4,5]. The 3 phthisic eyes operated elsewhere illustrate that pediatric cataract surgery is best undertaken in centres with sufficient surgical equipment and expertise. However, other eye centres found a lower PCO rate in eyes without intraoperative capsulotomy (35 to 37.5%) and eyes initially treated with primary vitrector capsulotomy (1.6%-5.4%) [4,5]. The longer follow-up and prospective follow-up visit in our study could partly explain this difference, but adequate sized posterior capsulotomies and complete anterior vitrectomy are important to avoid PCO [16,17]. The prevalence of ocular hypertension in our study was low, but the age at operation was higher than in other studies and glaucoma is known to be more commonly associated with surgery very early in life [18]. Glaucoma can also develop well beyond the follow-up time of this study [18].

Limitations

Although we examined all patients in a prospective manner, surgical data collection was retrospective. The retrospective character of our study inevitably introduced selection bias due to missing data. Although the participation rate was good, we cannot rule out any bias from a lack of information on children that were not found. Furthermore, the lack of uniformity among cases regarding biometry, types of A-scans, surgeon, location of IOL, and in posterior capsulotomy can also cause bias in the results.

Conclusion

In conclusion, based on a functional questionnaire this study found that after bilateral cataract surgery, over two thirds of cataract children function normally in their daily life. Despite equally good quality surgery, the visual acuity outcome was worse than in some other African eye centres, equipped with orthoptic and low vision departments for amblyopia management. The introduction of similar facilities with a strong community liaison is recommended to improve the visual outcome by better compliance to optical prescriptions and regular follow-up. Efforts to find children earlier and to improve general anaesthesia safety will allow surgery at an earlier age, leading to better visual results.

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