Surgical Results in the Management of Advanced Primary Congenital Glaucoma in a Rural Pediatric Population

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Objective: To present the anatomic and functional results of surgical treatment for advanced primary congenital glaucoma (PCG) in a rural setting.

Design: Retrospective, observational case series.

Participants: Forty eyes of 22 consecutive patients diagnosed with PCG and who underwent surgical treatment.

Methods: All eyes underwent surgical treatment for PCG. Type of surgery and postoperative complications were noted. We examined anatomic and functional indices before and after the operation.

Main Outcome Measures: Visual acuity (VA), intraocular pressure (IOP), refractive spherical error, cup-to-disc ratio (CDR), and horizontal corneal diameter (HCD).

Results: Average age at the time of surgery was 3.3 years (range, 0.4–10) and the mean follow-up was 6 months (range, 1–11). 15% showed marked lens dislocation owing to the severe buphthalmos at presentation. Preoperative IOP was 54±2 mmHg, HCD was 15.1±0.3 mm, and CDR (when visible) was 0.8±0.02. Surgical intervention included 31 trabeculotomies, 6 Ahmed Glaucoma Valve implants, 1 goniotomy, and 2 eviscerations. Serious complications were noted in 4 eyes. Final postoperative IOP was 23±2 mmHg ($P<0.0001$). Patients were significantly more likely to have ambulatory VA (following objects or better) after operation (18% vs 64%; $P<0.0001$).

Conclusions: Our surgical outcomes in children with advanced PCG demonstrated moderate overall improvement in IOP and modest improvement of VA. Deep deprivation amblyopia, severe disease manifestation at presentation, opaque corneas, and frequent lens dislocation limited the possible success. These data further signify the need for effective, timely screening of children and prompt recognition by health care workers to reduce the rate of avoidable blindness in developing countries.

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Glaucoma is a disease of heterogeneous etiologies characterized by elevated intraocular pressure (IOP). In pediatric patients, glaucoma is defined as *primary* congenital glaucoma (PCG) when an isolated, idiopathic developmental anomaly of the anterior chamber angle exists and *secondary* when aqueous outflow is impaired due to ocular or systemic disease.[1,2] Clinically, PCG presents as a classic triad of tearing, photophobia, and blepharospasm. Common signs include elevated IOP, corneal clouding and Haab's striae, enlarged corneal diameter, and buphthalmos.

Although PCG is the most common glaucoma in infancy,[3] it presents so infrequently that large-scale epidemiologic studies are difficult to carry out. With an incidence of 1 in 10 000 to 18 000 live births, it has been estimated that a general ophthalmologist practicing in a nonspecialist center in North America or Western Europe will diagnose a new case of PCG every 5 years.[4,5] However, because the disease is often transmitted in an autosomal-recessive pattern, PCG has been reported to occur up to 10 times more frequently in certain ethnic and religious groups where consanguineous relationships, especially cousin–cousin inbreeding, is common.[4]

Despite its relatively low incidence, it has been calculated that PCG may comprise ≥5% of the general glaucoma population owing to the greatly prolonged life expectancy of a newborn as compared with an elderly patient with primary open angle glaucoma. Although operative intervention remains the primary therapy for this disease, recent pediatric literature has often demonstrated limited clinical success.[6,7]

This study demonstrates the surgical outcomes of patients diagnosed with extremely advanced PCG over a 1-year period in rural southern Ethiopia.

Methods

A retrospective study of all consecutive pediatric patients diagnosed with PCG during 2007 and 2008 in rural southern Ethiopia

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was conducted at a single center at Hawassa University School of Medicine. The hospital is a referral center for an estimated population of 15 million people; nearly half are children <15 years of age.

This work was part of the ORBIS international and Cyber-Sight project implementing pediatric ophthalmology services in Ethiopia. The work was approved by the regional institutional ethics review board. All patients were diagnosed with PCG based on standard clinical assessment and criteria. No other ocular or systemic conditions were noted. All patients underwent clinical examination and evaluation under anesthesia followed immediately by operative treatment. The examination included anterior segment evaluation in addition to visual acuity (VA), horizontal corneal diameter (HCD) measurement, IOP, cup-to-disc ratio, and cycloplegic refraction. The VA was measured by an unaware eye care personal with the aid of local translation to the tribal language. The IOP was measured using the Tono-Pen XL (Reichert, Depew, NY) and VA was measured or estimated according to patient age and cooperation.

Statistical analysis was performed using SPSS (version 13, SPSS Inc., Chicago, IL). All results are presented as mean values ± standard error of mean.

Results

Twenty-four consecutive patients (15 male, 9 female) were included in the study. The average age at diagnosis was 3.3±0.5 years. Two cases were lost to follow-up before operative intervention and were not included in further analysis. One pair of monozygotic twins was included in the study groups. Both presented at the age of 6 with bilateral advanced glaucoma (cases 27–30).[2] In total, 40 eyes of 22 patients underwent operative care.

Before surgery, all patients underwent a clinical evaluation of ocular indices (Table 1; available online at http://aaojournal.org). Seventeen eyes had poor ocular media clarity owing to extensive corneal opacities (Fig 1A, B), preventing refraction estimation in all and posterior pole examination in 9 eyes. Average refractive spherical error was −5.7±0.6 diopters (range, −15 to −1 diopters, measured in 23 eyes), cup-to-disc ratio was 0.8±0.02 (range, 0.5–1; 31 eyes), HCD was 15.1±0.3 mm (range, 11.3–18.5 mm; 40 eyes), and IOP was 54± 2 mmHg (range, 30–86 mmHg, 40 eyes).

At presentation, VA ranged from finger counting to no light perception, with 33 eyes having nonambulatory vision (hand motion or worse). Fourteen patients (58%) had signs of temporal scarring on the face (Fig 1C), indicating previous traditional treatment. Six eyes (15%) presented with lens dislocation (Fig 1D), reflecting severe buphthalmos owing to long-lasting increased IOP.

Thirty-one eyes underwent trabeculotomy as the first procedure; in 6 cases, an Ahmed Glaucoma Valve (AGV) was implanted. Two eyes that had undergone spontaneous perforation owing to prolonged IOP elevation and were blind and painful were eviscerated (Fig 1E). In only 1 case was the cornea sufficiently clear to be treated with a goniotomy. Of the 6 patients presenting with lens dislocation, 1 was lost to follow-up before surgery was performed, 2 presented with spontaneous perforation and underwent evisceration, and in 3 cases a lensectomy was performed in addition to the scheduled operation (in 2 cases a trabeculotomy and in the third AGV implantation). Serious complications after surgery included 2 cases of AGV extrusion, 1 phthisis bulbi, and 1 retinal detachment.

Twelve secondary procedures in 12 eyes were carried out because of persistently elevated IOP. In 6 eyes, additional trabeculotomy was performed and 4 AVGs were implanted, including the replacement of the 2 that were extruded after the primary implantation. The retinal detachment was repaired and 1 painful, blind eye was eviscerated.

Postoperative evaluation revealed statistically significant differences in only 2 preoperative indices: IOP and VA. The average postoperative IOP was significantly lower (23±2 mmHg; range, 1–50; $P<0.0001$; Student t-test; Fig 2A), with 43% achieving an IOP measurement of <22 mmHg. No correlation was found between age at presentation and final IOP measurements. All VA results were functionally divided into 2 categories: Nonambulatory (hand motion or worse) and ambulatory (following objects or better). Patients were significantly more likely to have ambulatory VA after the operation (18% vs 64%; $P<0.0001$; chi-square test; Fig 2B). The HCD, corneal clarity, and cup-to-disc ratio did not differ significantly after operation (data not shown).

Discussion

Glaucoma is a disease of heterogeneous etiologies characterized by elevated IOP that later results in enlarged globe, corneal clouding, and optic atrophy. In some cases, this is followed by lens dislocation and even globe perforation. Primary congenital glaucoma is classified by an isolated, idiopathic developmental anomaly of the anterior chamber angle. Because of its relatively low incidence, leading to decreased awareness, definitive diagnosis can be delayed and subsequent treatment may be inadequate because of the advanced disease state.[4] This delay very likely contributes to the disproportionately high percentage of glaucoma-induced blindness in children: Roughly 18% of children in blind institutions and 5% of overall pediatric blindness worldwide.[8,9] Surgery is the accepted treatment method, with medical therapy playing only an adjunctive role.

In this retrospective study, we present the results of 40 consecutive eyes surgically treated for PCG in a rural African setting that has limited medical availability. Patients were diagnosed and treated at a relatively late age (3.3±0.5 years). All eyes underwent surgical procedures and were observed for up to 11 months after the operation. We found that, after operative intervention, there was (1) a reduction in IOP measurements and (2) a higher rate of ambulatory VA. We also determined that a relatively high percentage of eyes were treated with evisceration and a high rate of AGV extrusion occurred, both likely to be related to the late presentation of patients.

The objective of surgery for PCG is to maintain visual function and forestall structural changes to the eye by reducing IOP. In our cohort of patients, the average IOP was significantly reduced (23±2 mmHg) compared with preoperative measurements (54±2 mmHg). Recent reports on surgical treatment options for PCG present success rates in reducing IOP <22 mmHg ranging from 54% to 90%.[7,10,11] Our own patients showed a more modest success rate, possibly reflecting the extremely high preoperative IOP levels (54±2 mmHg). Thus, our patients, who represent a more advanced and long standing disease, resulted in a smaller percentage reaching the desired IOP range. Such advanced disease may also reflect on the lack of correlation between age and IOP. Furthermore, no routine pharmacologic treatment is available to patients in such rural settings; none of the patients in this study received prior or adjuvant

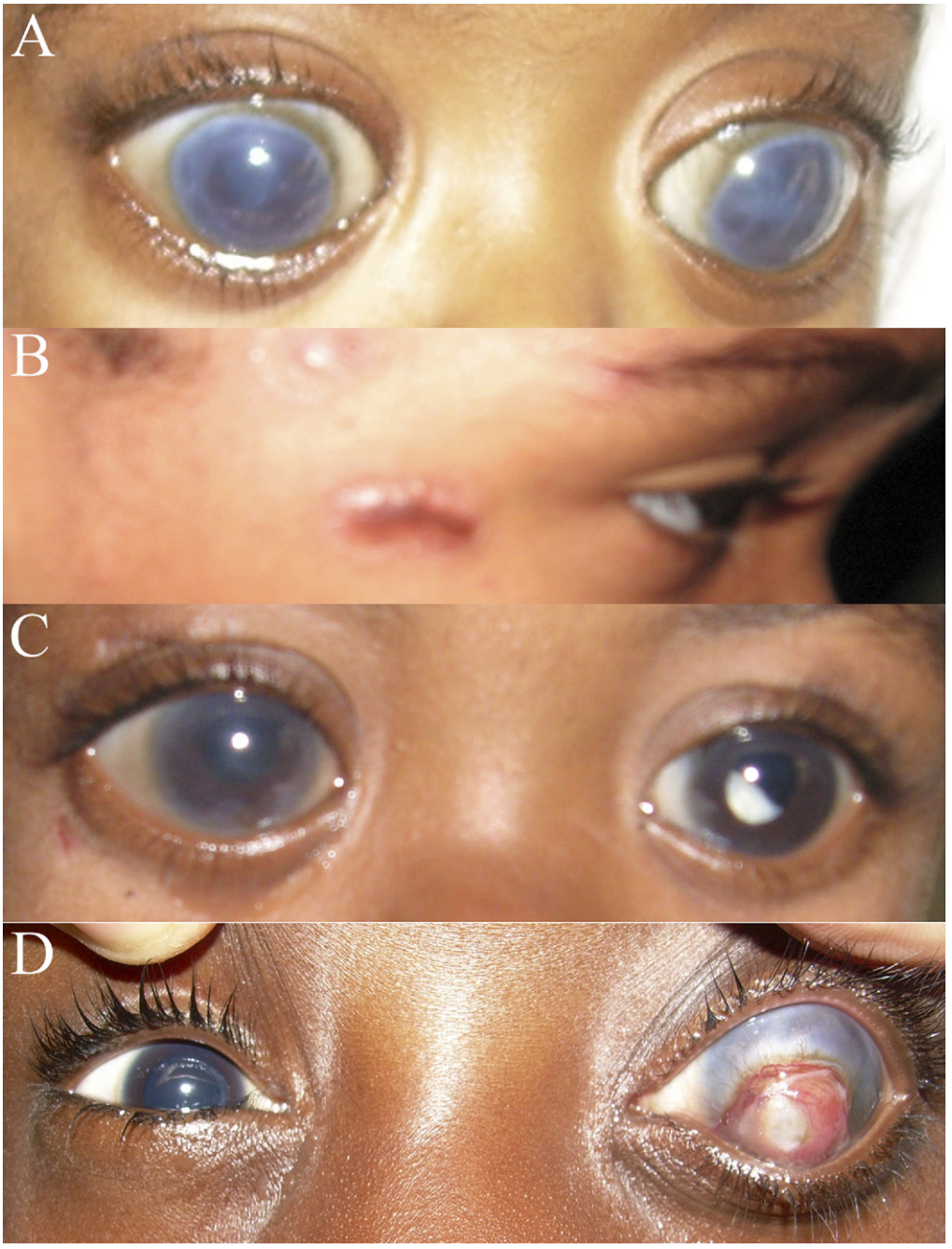

Figure 1. Four cases of primary congenital glaucoma. **A**, Bilateral Haab's striae. **B**, Temporal traditional scarring. **C**, Left eye inferior dislocation of a mature cataract. **D**, Left eye spontaneous perforation owing to prolonged elevation of intraocular pressure.

medical therapy. Nevertheless, after surgery, the average IOP in our cohort was reduced by a factor of 2.4. Those who were implanted with a shunt device achieved an IOP <22 mmHg 75% of the time.

Management of IOP in glaucoma patients intends to minimize any further visual deterioration, with the additional aim of obtaining some degree of improvement in vision. Our results demonstrate some success with this goal in that a significant improvement in VA occurred after surgery (Table 1), with 64% of patients reaching ambulatory vision. Several groups have reported improvement in VA scoring after surgical treatment of PCG.[12,13] Alsheikheh et al[10] found a corrected VA of ≥0.32 in 35 of 66 eyes (53%) in patients that underwent surgery for primary or secondary glaucoma.[10] A recent retrospective study found VA >0.4 in 66.22% of PCG patients after surgery.[14] Although we noted an improvement in VA, any interpretation of such results must be guarded. The young age of our patients, many of whom were preliterate or even preverbal, as well as cultural and behavioral differences may cause

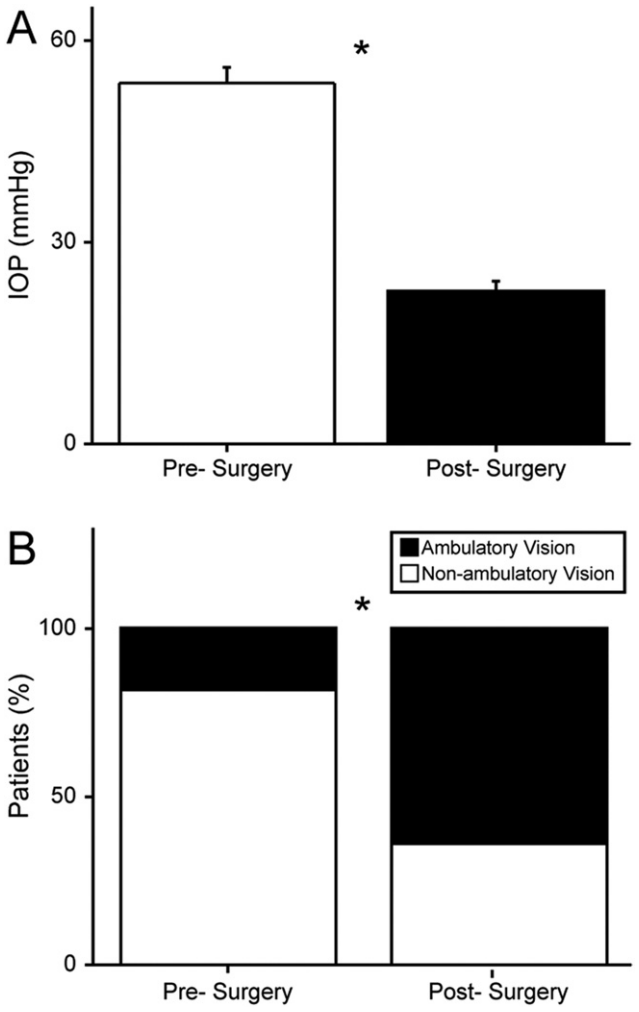

Figure 2. Intraocular pressure (IOP) and visual acuity changes after surgery. **A**, The IOP was reduced on average after surgery, from 54±2 to 23±2 mmHg. **B**, The percentage of ambulatory visual acuity increased among patients after surgery from 18% to 64%. *$P<0.0001$.

underestimation in VA results. In an attempt to minimize any imprecise interpretation of the results, we grouped all VA categories into 2 groups: Nonambulatory (hand motion or worse) and ambulatory (following objects or better) visual capabilities. Improvements in VA remained significant both when tested in the traditional way and when modified ambulatory categories were evaluated. The advanced stage of glaucoma discovered in our patients may also have affected their VA function, because prolonged deprivation amblyopia, corneal opacities, and uncorrected high myopia are all known to cause poor visual function in PCG patients, adequate IOP control notwithstanding.[15,16]

Of the 40 eyes that underwent primary surgery, 4 developed serious complications, including 2 cases with AGV extrusion (out of 6 primary valve implantations). This high rate of implant extrusion may reflect long-standing, severe disease. Both patients had exceptionally elevated IOP (86 and 85 mmHg) and wide HCDs (17 and 14 mm), reflecting an extremely uncontrolled, severe, and long-lasting disease. Such high IOP may have an effect on ocular structure, including scleral thickness and rigidity, thereby possibly affecting implant stability and lasting durability.[17] However, we cannot rule out that implant rigidity played a role in this high extrusion rate. All AGVs we used in this study were polypropylene models (S-2) rather than silicone (FP7). A recent retrospective study by Khan and Al-Mobarak[18] suggested that at 2 years of follow-up, silicone AGVs survived longer than polyprophylene AGVs. Therefore, the rigidity of the polyprophylene AGVs coupled with buphthalmic eyes may have also contributed to the high rate of extrusion.[19]

A key drawback to our study is the limited time for follow-up: The average time was 6 months and the longest was 11 months. Most studies agree that the success of pediatric glaucoma operations deteriorates with time, as reflected by the increased need to perform further procedures with increasing age.[20–22] Therefore, the relatively small number of secondary operations performed during our study (27.5%) may reflect this short-term follow-up.

One of the greatest limitations in the care of PCG patients is the frequent delay in presentation. A recent study in Germany demonstrated that even in areas with sufficient access to health care, the mean interval between detection and initial presentation to an ophthalmologist was 2.2 months.[10] The presenting age in the current study was >3 years of age, underscoring the barriers to health care in this population. This may be the cause for the advanced cases we observed and possibly for the lower success and higher complication rate. In the literature, operative success has been related to various variables including regular follow-up visits,[14] ethnic background, and gender.[23] However, in our present study none of these have been found to relate to the surgical prognosis. Although surgical success rates for PCG range up to 90%,[10,11,24] the more advanced conditions, which may result in higher IOP and buphthalmos, may also have a more guarded prognosis. The presenting age may also explain the high occurrence of traditional remedies. This form of therapy is considered the mainstay in such rural regions and may explain the poor outcome seen in some cases, including extreme cases of patients who sought medical intervention only after spontaneous globe rupture.

The outcomes presented in this study highlight the limited effect achievable in cases with delayed intervention in children with PCG. They further signify the need for effective, timely screening of children and prompt recognition by health care workers to reduce the rate of avoidable blindness in developing countries. We reaffirm the sentiments of many recent reports by emphasizing the need for large-scale, multicenter clinical trials evaluating operative techniques and developing a standard for the diagnosis and treatment of congenital glaucoma.

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Table 1. Preoperative, Operative, and Postoperative Data of All Eyes Included in the Study

Patient No.	Preoperatively									Postoperatively	
#	*Age (yr)*	*VA*	*IOP (mmHg)*	*HCD (mm)*	*Refraction (Diopter)*	*CDR*	**Operation**	**Complications**	**Secondary Operation**	*VA*	*IOP (mmHg)*
1	1.5	—	60	15.5	—	0.9	TS	—	—	FO	25
2	1.5	—	52	15.25	—	0.9	TS	—	—	FO	32
3	1.5	LP	73	17	—	—	TS	—	—	FO	36
4	1.5	LP	68	17.5	—	—	TS	—	—	FO	25
5	1	FF	32	14	−3	0.6	TS	—	—	FO	17
6	1	LP	50	16	−6	0.9	AV S2	—	—	FO	20
7	2	LP	54	16	−6	0.9	TS	—	TS	FO	34
8	2	LP	57	16	−7	0.9	TS	—	—	FO	14
9	0.9	LP	58	16	−6	0.9	TS	—	—	LP	36
10	0.9	LP	51	15.75	−7	0.9	TS	—	—	LP	31
11	0.4	LP	86	14	−7	0.9	AV S2	Ahmed valve extrusion	AV S2	LP	50
12	0.4	LP	40	11.5	−2	0.55	TS	—	—	FF	16
13	0.7	LP	52	13.25	−4	0.7	TS	—	—	FF	24
14	0.7	LP	64	13.75	−6	0.8	TS	—	TS	FF	26
15	0.5	FF	30	11.25	−1	0.5	TS	—	—	FF	16
16	0.5	LP	46	12.75	−3	0.8	TS	—	—	FF	19
17	0.5	LP	85	17	—	—	AV S2	Ahmed valve extrusion	AV S2	LP	42
18	0.5	FF	41	13	−2	0.8	TS	—	—	FF	24
19	2.5	LP	52	16.5	−15	0.9	TS	—	—	FF	24
20	2.5	LP	41	16.75	—	—	TS	—	AV S2	LP	16
21	5	HM	50	15.75	—	0.9	TS	—	—	FC 1M	26
22	5	HM	48	15.5	—	0.9	AV S2	—	—	FC 1.5M	18
23	6	LP	55	15.5	−7	0.8	AV S2	—	TS	FC 1M	17
24	6	FC 1M	45	15.25	−5.5	0.8	TS	—	—	FC 3M	24
25	10	LP	50	16.5	—	1	TS	—	TS	HM	24
26	10	LP	60	16.75	—	1	TS	—	—	HM	22
27	6	LP	62	17	—	0.9	TS	—	AV S2	FC 2M	18
28	6	LP	68	16.75	—	—	TS	Retinal detachment	Scleral buckle	LP	5
29	6	LP	48	15.25	−9	0.9	TS	—	TS	FC 1M	21
30	6	NLP	63	16.5	—	—	TS	Phthisis bulbi	—	NLP	1
31	5	FC 1M	38	13.5	−7	0.9	TS	—	—	FC 3M	16
32	5	FC 2M	31	12.5	−5	0.7	TS	—	—	20/120	18
33	2.5	LP	42	14	−8	0.8	TS	—	TS	FF	22
34	2.5	LP	35	14.25	−9	0.9	AV S2	—	—	LP	17
35	0.4	NLP	82	16	—	—	TS	—	Evisceration	NLP	—
36	3	FF	32	11.75	−1.5	0.55	Goniotomy	—	—	FF	15
37	3	LP	46	13.5	−4	0.8	TS	—	—	LP	24
38	0.75	LP	50	14	—	0.9	TS	—	—	LP	24
39	9	NLP	80	18.5	—	—	Evisceration	—	—	NLP	—
40	10	NLP	70	18	—	—	Evisceration	—	—	NLP	—

AV S2 = Ahmed valve S2 model; CDR = cup-to-disc ratio; FC = fingers count; FF = fixate and follow; FO = follow object; HCD = horizontal corneal diameter; HM = hand movements; IOP = intraocular pressure; LP = light perception; NLP = no light perception; TS = trabeculotomy superior location; VA = visual acuity.