

# Ocular Hypertension and Secondary Glaucoma in Children with Uveitis

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**Purpose:** To identify the risk factors for ocular hypertension and secondary glaucoma in children with uveitis.

**Design:** Retrospective observational case series of 147 patient records.

**Participants:** Two hundred fifty-six eyes of 147 children with uveitis diagnosed before the age of 16 years.

**Methods:** Data were obtained from the medical records of children with uveitis evaluated at our institute from 1990 through 2004.

**Main Outcome Measures:** Localization and course of uveitis (acute or chronic), underlying systemic disease, onset of ocular hypertension, onset of secondary glaucoma, treatment with steroids, antinuclear antibodies (ANAs), lens extractions, number of blind eyes at onset and during follow-up, and the duration of follow-up.

**Results:** Elevated intraocular pressure developed in 35% of children with pediatric uveitis regardless of the form or type of uveitis during a follow-up of 5 years. Secondary glaucoma, however, developed more frequently in juvenile idiopathic arthritis-associated uveitis (38%) compared with other forms of uveitis (11%) and more frequently in children with uveitis who were ANA positive (42%) than in those who were ANA negative (6%). Elevated intraocular pressure occurred in two thirds of all children within the first 2 years after the diagnosis of uveitis. Except for patients with juvenile idiopathic arthritis-associated uveitis, periocular steroid injections represented an additional risk factor for secondary glaucoma, but this risk was limited to the early phase of the disease process.

**Conclusions:** In children with uveitis in this series, juvenile idiopathic arthritis-associated uveitis and ANA-positive uveitis without evidence of arthritis are the most important risk factors for developing secondary glaucoma. *Ophthalmology* 2006;113:853–859 © 2006 by the American Academy of Ophthalmology.



Secondary glaucoma (SG) is a frequent complication of uveitis and a major cause of visual loss in children with uveitis.<sup>1</sup> Kanski and Shun-Shin<sup>2</sup> reported that one third of the glaucomatous eyes of children with uveitis resulted in no light perception. There are several explanations for this poor prognosis, such as a late detection as a result of uncooperative patients, lack of response to conventional glaucoma treatment, and poor results of conventional glaucoma surgery.<sup>3</sup> In the general uveitis population, SG is most frequently associated with chronic granulomatous anterior uveitis of unknown origin or with uveitis associated with sarcoidosis and juvenile idiopathic arthritis (JIA).<sup>4</sup> Because

the visual prognosis of SG in children is poor, prevention, early detection, or both may improve the visual prognosis in this population. The purpose of our study was to investigate which children with uveitis are at increased risk of experiencing elevated intraocular pressure (ocular hypertension, SG, or both), particularly combined with poor visual outcome. Special attention was paid to anatomic type and causes of uveitis, associated systemic diseases, various treatment methods, and previous cataract surgery.

## Patients and Methods

We reviewed the medical records of 173 children with uveitis. These children were identified in a complete database search of the FC Donders Institute of Ophthalmology, University Medical Center, Utrecht, The Netherlands, from 1990 up to and including 2004. Only those patients with onset of ocular inflammation before the age of 16 years and follow-up of at least 6 months were included in this study. Our center combines a secondary and a tertiary referral function. Children were referred by the ophthalmologists of secondary referral hospitals or by the pediatric rheumatologists of our medical center. The pediatric rheumatologists referred children for uveitis screening according to the criteria of the American Academy of Pediatrics in cases of JIA or other systemic diseases.<sup>5</sup> We recorded the following clinical data for each patient: gender,

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Table 1. Study Population

	6-mo Follow-up	1-yr Follow-up	3-yr Follow-up	5-yr Follow-up	10-yr Follow-up
No. of patients in follow-up	147	133	97	62	31
Mean age at onset of uveitis (yrs)	8.4	8.1	7.7	7.1	6.5

race, family history of glaucoma, age at onset of uveitis, localization and course of uveitis (acute or chronic), laterality, underlying systemic disease, antinuclear antibody (ANA) status, onset of ocular hypertension (OHT), onset of SG, treatment with periocular or systemic steroids, cataract surgery, number of blind eyes at onset and during follow-up, and the duration of follow-up.

Diagnosis of uveitis was based on the criteria of the International Uveitis Study Group.<sup>6</sup> The uveitis was considered chronic if the duration of active ocular inflammation was longer than 3 months.<sup>1</sup> The diagnosis of JIA was made according to the criteria from the International League against Rheumatism.<sup>7,8</sup> In cases of presumed JIA, the diagnosis was confirmed by a pediatric rheumatologist. The presence of other systemic diseases associated with uveitis was assessed according to current diagnostic criteria. The ocular pressure was measured using applanation tonometry, but if this was not possible, noncontact tonometry or the Tono-Pen (Medtronic Ophthalmics, Minneapolis, MN) was used. In 2 patients, it was necessary to evaluate intraocular pressure (IOP) under general anesthesia. Gonioscopic evaluation of the anterior chamber was performed only in selected patients, most of the time in older children. For young patients, this examination needs general anesthesia, which we try to avoid where possible. Secondary glaucoma was defined as the presence of pathologic cupping of the optic disc, a glaucomatous visual field defect with IOP higher than 21 mmHg, or both.<sup>4</sup> We defined OHT as 3 successive IOP measurements higher than 21 mmHg, single eye pressure higher than 30 mmHg (to exclude temporary or slight elevations of IOP), or any IOP higher than 21 mmHg for which glaucomatous treatment had been started in the absence of pathologic optic disc cupping or visual field changes.<sup>9</sup> In this study, the term *elevated IOP* encompasses both OHT and SG. Blindness was defined according to the World Health Organization criteria (profound vision loss, that is, visual acuity of less than counting fingers at 3 meters or a central visual field of less than 10°, or tunnel vision).<sup>10</sup> We analyzed the clinical data at the following points after the diagnosis of uveitis; 6 months and 1, 3, 5, 7, and 10 years.

Statistical analysis of the data was performed by using the SPSS statistical software package version 12.0.1 (SPSS Inc., Chicago, IL). The Pearson chi-square test or the Fisher exact test (>20% of cells have an expected count of fewer than 5) were used to compare possible associations between categorical variables. A 1-way analysis of variance with the Bonferroni correction was used for multiple comparisons. We applied the binary logistic regression analysis to identify predictive factors. *P* values less than 0.05 were considered to be statistically significant.

## Results

### General Characteristics

From a total of 173 patients with childhood uveitis, 147 patients were included in the analysis. Twenty-six patients were excluded from this study because no information about the IOP was available (*n* = 12) or follow-up was less than 6 months (*n* = 14). Bilateral disease was observed in 109 (109/147; 74%) patients, resulting in 256 affected eyes. The mean duration of follow-up was 5 years (range, 0.5–10 years). The number of patients followed up and the mean age of onset of uveitis at different time points are shown in Table 1. The boy-to-girl ratio was 4:6. Family history regarding glaucoma was known for 79 children, of whom 2 (3%) were positive for glaucoma. Information about ethnic background was available for 66 children: white, *n* = 46 (70%); Mediterranean, *n* = 10 (15%); Asian, *n* = 5 (8%); black, *n* = 5 (8%).

### Elevated Intraocular Pressure

At 6 months after the diagnosis of uveitis, 21 of 147 (14%) children experienced elevated IOP in at least 1 eye (Table 2). The number of patients with elevated IOP increased during follow-up: 25 of 97 patients (26%) at 3 years, 22 of 62 patients (35%) at 5 years, and 12 of 31 patients (39%) at 10 years of follow-up. Secondary glaucoma was diagnosed in 8 of 97 patients (8%) at 3 years of follow-up (Table 2). At 5 years of follow-up, the percentage of children with uveitis in whom SG developed increased to 21% (13/62) and remained stable until the 10-year follow-up. After a follow-up of 5 years, 13 of 22 (59%) children with OHT experienced SG, and this percentage remained stable until the 10-year follow-up. The median length of time between the onset of uveitis and the development of elevated IOP (*n* = 54) was 1 year (mean, 1.9 years; range, 0–9 years; Fig 1).

No differences were found for developing IOP or SG between boys and girls, nor between different ethnic backgrounds. In children with elevated IOP, uveitis was bilateral in 23 of 25 (92%) and unilateral in 2 of 25 (8%) at the 3-year follow-up, compared with 50 of 72 (69%) children with bilateral uveitis and 22 of 72 (31%) children with unilateral uveitis in those who had no elevated IOP (*P* = 0.024).

### Clinical Course of Uveitis

There were no significant differences for developing elevated IOP and SG between those with chronic or acute uveitis (Table 3).

Table 2. Elevated Intraocular Pressure, Secondary Glaucoma,

	6-mo Follow-up (n = 147)			1-yr Follow-up (n = 133)		
	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)
No. of patients	18 (12)	3 (2)	21 (14)	20 (15)	4 (3)	24 (18)

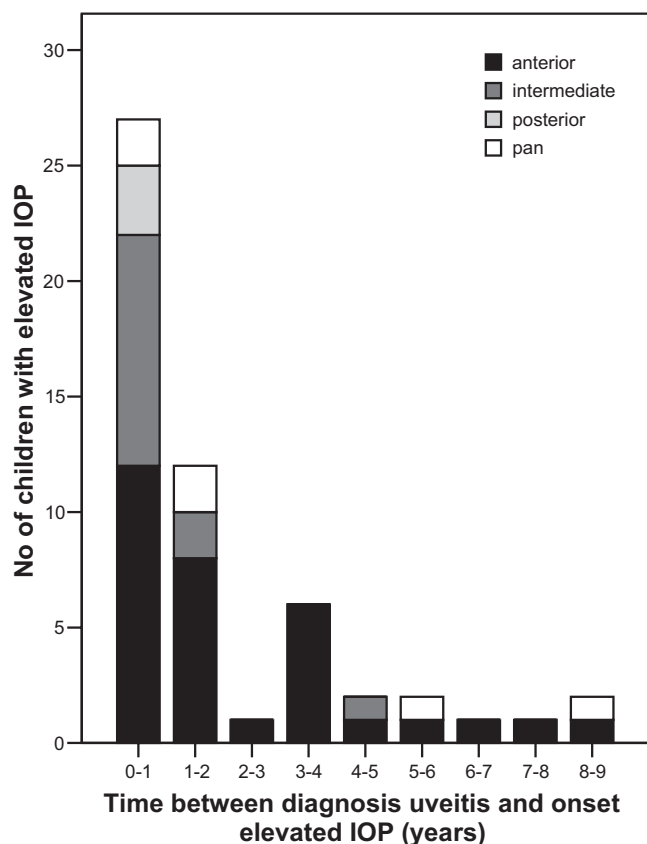


Figure 1. Bar graph showing the time taken to reach elevated intraocular pressure (IOP) after diagnosis of uveitis.

### Anatomic Classification of Uveitis

The number of patients with elevated IOP according to anatomic classification of ocular inflammation is shown in Table 4. Although intermediate uveitis had the highest percentage of elevated IOP during follow-up, no significant differences were observed between the different anatomic localizations of uveitis. At the 5-year of follow-up, 4 of 9 children with intermediate uveitis had OHT, but none of these patients progressed to SG (0/4; 0%), whereas 11 of 15 (73%) children with anterior uveitis and OHT progressed to SG ( $P = 0.018$ ).

The mean time between the onset of uveitis and the start of elevated IOP for the 4 different locations of uveitis is illustrated in Figure 1. Posterior and intermediate uveitis had a shorter interval between the clinical onset of uveitis and onset of elevated IOP (0.3 and 0.9 years, respectively) compared with anterior and panuveitis (2.3 and 2.9 years, respectively;  $P = 0.025$ , log-rank test): anterior versus intermediate uveitis ( $P = 0.016$ ) and posterior uveitis ( $P = 0.010$ ) and panuveitis versus posterior uveitis ( $P = 0.024$ ).

### Specific Uveitis Entities

A systemic disease was observed in 44 of 147 (30%) patients; the specific systemic and ocular diagnoses are shown in Table 5 (available at <http://aaojournal.org>).

**Juvenile Idiopathic Arthritis.** Juvenile idiopathic arthritis was the most commonly associated systemic disease (35/147; 24%) of the total population and formed the underlying disease for 35 (35/72; 49%) children with anterior uveitis. All children with JIA-associated uveitis had chronic anterior uveitis.

After 5 years of follow-up, no difference was found in developing elevated IOP between children with JIA-associated uveitis and children with uveitis not associated with JIA. However, SG was significantly more often noted in children with JIA-associated uveitis (9/24; 38%) compared with children with other uveitis entities (4/38; 11%) at the 5-year follow-up ( $P = 0.022$ ).

No differences in the development of elevated IOP (5/9; 56%) or SG (3/9; 33%) were found in children with JIA with onset of uveitis before the onset of arthritis compared with children with JIA in whom uveitis developed later on during the disease process (elevated IOP, 7/15 [47%]; or SG, 6/15 [40%]; not significant).

**Antinuclear Antibodies.** Of the 40 patients tested for the presence of ANAs, 24 were positive: 19 patients with JIA-associated uveitis and 5 patients with uveitis of unknown cause after 5 years of follow-up. Fourteen of the 24 (58%) ANA-positive children had elevated IOP compared with 5 of 16 (31%) ANA-negative children during a follow-up of 5 years ( $P = 0.093$ ). Secondary glaucoma was significantly more often observed in ANA-positive children (10/24; 42%) than in ANA-negative (1/16; 6%) children at 5 years of follow-up ( $P = 0.027$ ). For the ANA-positive patients, there was no difference found between JIA-associated uveitis and uveitis of unknown origin in developing elevated IOP or SG.

### Lens Extraction

Twenty-eight eyes had undergone lens extraction and had a follow-up of 3 years after surgery. Seven of these eyes (7/28; 25%) had preexisting elevated IOP. Of the remaining 21 eyes, 38% (8/21) experienced elevated IOP and 19% (4/21) experienced SG within 3 years after lens extraction. All the eyes had anterior uveitis except for 1 case of panuveitis, and in 17 of 21 eyes, the uveitis was associated with JIA. Eyes of patients with JIA-associated uveitis had less SG after cataract surgery than eyes of patients with anterior uveitis not associated with JIA (1/17 [6%] vs. 3/3 [100%];  $P = 0.004$ ).

### Periocular or Systemic Steroids

Eyes treated with periocular steroid injections more frequently experienced elevated IOP than eyes not treated with steroid injections (Table 6). Secondary glaucoma was observed more frequently after periocular steroid injections than in patients not treated with periocular injections only at 6 months of follow-up (3/43 eyes vs. 1/213 eyes;  $P = 0.016$ ). The number of injections

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3-yr Follow-up (n = 97)			5-yr Follow-up (n = 62)			10-yr Follow-up (n = 31)		
Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)
17 (18)	8 (8)	25 (26)	9 (15)	13 (21)	22 (35)	6 (19)	7 (23)	12 (39)

Table 3. Elevated Intraocular Pressure, Secondary Glaucoma, and Ocular

	6-mo Follow-up (n = 147)				1-yr Follow-up (n = 133)				3-yr Follow-up	
	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)
Acute uveitis	24	2 (8)	0 (0)	2 (8)	23	1 (4)	1 (4)	2 (9)	14	0 (0)
Chronic uveitis	123	16 (13)	3 (2)	19 (15)	110	19 (17)	3 (3)	22 (20)	83	17 (20)
P value			1.000	0.529			0.537	0.248		

\*If the divisor is less than 10, no percentages are shown.

had no influence on the development of elevated IOP (1-way analysis of variance, Bonferroni, not significant).

In children with JIA-associated uveitis, there was no difference in elevated IOP (3/15 eyes; 20%) and SG (2/15 eyes; 13%) development after periocular steroid injections compared with patients without injections (elevated IOP, 15/40 eyes [38%];  $P = 0.335$ ; and SG, 4/40 eyes [10%];  $P = 0.660$ ) during a follow-up of 3 years.

During a follow-up of 3 years, eyes with intermediate uveitis (19/33; 58%) received more periocular steroid injections than eyes with anterior uveitis (19/85; 22%), posterior uveitis (2/24; 8%), and panuveitis (5/25 [20%];  $P < 0.05$ , 1-way analysis of variance, Bonferroni). In children with intermediate uveitis, during 3 years of follow-up, there tended to be more cases of elevated IOP after periocular steroid administration than in children not receiving steroid injections (9/19 eyes [48%] vs. 2/14 eyes [14%];  $P = 0.067$ ), although this did not reach significance. However, no SG was found in children with intermediate uveitis treated with periocular steroid injections ( $n = 19$  eyes) and not treated with steroid injections ( $n = 14$  eyes) during a follow-up of 3 years.

Systemic steroids were of no influence on the development of elevated IOP or SG.

### Secondary Glaucoma and Visual Outcome

One blind eye (1/256, 0%) was observed at the onset of uveitis and 10 blind eyes were observed during follow-up, all unilateral (Table 7). These blind eyes had a mean follow-up of 3.5 years (range, 0.0–7.8 years). Blind eyes resulting from SG were present in 3 of them, all with chronic, bilateral, ANA-positive uveitis and associated with JIA ( $n = 2$ ) or uveitis of unknown origin ( $n = 1$ ). Other causes of blindness were: cystoid macular edema ( $n = 1$ ), optic atrophy in multiple sclerosis ( $n = 1$ ), exudative retinal detachment ( $n = 1$ ), subretinal neovascularization ( $n = 1$ ), and diverse surgical complications ( $n = 3$ ).

### Discussion

Our study shows that children with JIA-associated uveitis are at higher risk of experiencing SG compared with children with uveitis not associated with JIA after a follow-up of 5 years ( $P < 0.022$ ). The risk of development of OHT was similar for all the pediatric uveitis entities included. Additional risk factors for SG in pediatric uveitis were periocular steroid injections shortly after the onset of uveitis and positive ANA status. The number of periocular injections, however, was of no influence on the development of elevated IOP. For children with JIA-associated uveitis, these additional risk factors, such as steroid injections and positive ANA, were not associated with the development of elevated IOP or SG. These observations reveal that JIA itself forms an independent risk factor for developing SG.

Sex, race, localization, chronic or acute course of uveitis, and the administration of systemic steroids had no influence on the development of elevated IOP or SG in pediatric uveitis. This is in contrast with SG in adult uveitis patients, where SG occurred more frequently with chronic uveitis.<sup>11</sup> Previously, it was reported that girls with JIA are at higher risk of developing uveitis, but boys with uveitis have more complications and are at risk of a poor visual outcome.<sup>12,13</sup> In our study, however, gender had no influence on developing elevated IOP or SG.

We found similar percentages of elevated IOP (OHT, SG, or both) as those mentioned in the study of Rosenberg et al,<sup>14</sup> who observed SG, OHT, or both in 11.4%, 15.3%, 24.1%, 30.8%, and 45.5% during a follow-up of, respectively, 6 months, 1, 3, 5, and 10 years in children with

Table 4. Elevated Intraocular Pressure, Secondary Glaucoma, and Ocular

	6-mo Follow-up (n = 147)				1-yr Follow-up (n = 133)				3-yr Follow-up	
	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)
Anterior uveitis	72	8 (11)	1 (1)	9 (13)	64	9 (14)	1 (2)	10 (16)	49	9 (18)
Intermediate uveitis	34	6 (18)	1 (3)	7 (21)	30	7 (23)	1 (3)	8 (27)	19	7 (37)
Posterior uveitis	22	3 (14)	0 (0)	3 (14)	21	2 (10)	1 (5)	3 (14)	16	1 (6)
Panuveitis	19	1 (5)	1 (5)	2 (11)	18	2 (11)	1 (6)	3 (17)	13	0 (0)
P value			0.322	0.528			0.214	0.512		

\*If the divisor is less than 10 no percentages are shown.

## Hypertension According to Course of Pediatric Uveitis

(n = 97)		5-yr Follow-up (n = 62)				10-yr Follow-up (n = 31)			
Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)
1 (7)	1 (7)	10	0 (0)	1 (10)	1 (10)	3	0*	0*	0*
7 (8)	24 (29)	52	9 (17)	12 (23)	21 (40)	28	5 (18)	7 (25)	12 (43)
1.000	0.107			0.673	0.082			1.000	0.265

uveitis. Our study population comprised a population similar to that of the study by Rosenberg et al concerning sample size, gender, bilateralism, and age at diagnosis of uveitis. Rosenberg et al compared their study population with several other series and concluded that their results were representative of pediatric uveitis in general. Although our study population is similar to that of Rosenberg et al, we cannot entirely exclude that the severity of the disease has led to a follow-up bias. Children with more severe uveitis might have come for a longer follow-up. The baseline features (localization and course of uveitis and number of patients requiring systemic treatment) of patients with short (<5 years) and long (>5 years) follow-up did not differ. However, the number of patients with JIA-associated uveitis was significantly higher in the group of patients with follow-up longer than 5 years. The study by Chalom et al<sup>15</sup> showed that ANA-positive children experienced uveitis more frequently, but ANA-negative children with uveitis had more ocular complications. This seems to be in contrast to our findings, in which SG occurred more frequently in ANA-positive uveitis. However, Chalom et al did not specify the different complications (synechiae, cataract, band keratopathy, and glaucoma), and the exact percentages of SG are not reported. This may explain the discrepancy between their and our observations.

The observation that none of the patients with elevated IOP with intermediate uveitis progressed to SG compared with one third of the patients with anterior uveitis may indicate that elevated IOP in intermediate uveitis is probably more temporary, less threatening, or both, than elevated IOP in anterior uveitis. In our population, borderline association between elevated IOP and steroid injections in children with intermediate uveitis was observed during a follow-up of 3

years. In addition, periocular steroid injections were administered more frequently in this group than in other anatomical types of uveitis. From our data, it is not obvious whether treatment with periocular steroid injections was responsible for elevated IOP or whether these children, treated with injections, had a more severe uveitis resulting in damage to the trabecular meshwork, ciliary body, or both. The observation that multiple steroid injections did not increase further the risk of elevated IOP supports the hypothesis that the ocular damage resulting from uveitis may be responsible for elevated IOP, but it also may indicate that elevated IOP after periocular steroid injection is linked to an individual high responder. The observation that the association between steroid injections and elevated IOP was not present at all time points may be explained by the fact that the development of elevated IOP in uveitis is dependent on several factors, of which steroid injections is only one.

Two thirds of all children with OHT or SG experienced elevated IOP in the first 2 years after the onset of uveitis, but elevated IOP also can manifest itself after a more extended interval after the onset of uveitis, which makes it very imperative to check the IOP regularly. Although there were no significant differences between the 4 different anatomical localizations of uveitis in developing elevated IOP, posterior and intermediate uveitis had a significantly shorter interval between the diagnosis of uveitis and the onset of elevated IOP compared with anterior and panuveitis. This discrepancy may be explained in part by the fact that children with intermediate uveitis received more periocular steroid injections.

In our series, SG seemed not to be negatively influenced by previous lens extraction. When we roughly compare

## Hypertension According to Anatomic Classification in Pediatric Uveitis

(n = 97)		5-yr Follow-up (n = 62)				10-yr Follow-up (n = 31)			
Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)
5 (10)	14 (29)	36	4 (11)	11 (31)	15 (42)	14	1 (7)	5 (36)	6 (43)
0 (0)	7 (37)	9	4*	0*	4*	6	2*	1*	3*
1 (6)	2 (13)	9	1*	1*	2*	4	0*	0*	0*
2 (15)	2 (15)	8	0*	1*	1*	7	2*	1*	3*
0.474	0.114			0.067	0.055			0.119	0.380

Table 6. Elevated Intraocular Pressure, Secondary Glaucoma, and Ocular

	6-mo Follow-up (n = 256)				1-yr Follow-up (n = 234)				3-yr Follow-up	
	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)
Injection+	43	8 (19)	3 (7)	11 (26)	51	12 (24)	3 (6)	15 (29)	45	11 (24)
Injection-	213	16 (8)	1 (0)	17 (8)	183	17 (9)	3 (2)	20 (11)	122	17 (14)
P value			0.016	0.001			0.119	0.001		

Table 7. Blind Eyes in Patients with Pediatric Uveitis

	6-mo Follow-up	1-yr Follow-up	3-yr Follow-up	5-yr Follow-up	10-yr Follow-up
No. of patients	147	133	97	62	31
Patients with unilateral blind eye resulting from SG (%)	0 (0)	0 (0)	1 (1)	1 (2)	3 (10)
Total no. of patients with unilateral blind eye (%)	1 (1)	4 (3)	4 (4)	4 (6)	9 (29)
JIA	0	1	1	1	4
Unknown	1	3	3	3	4
MS	0	0	0	0	1

JIA = juvenile idiopathic arthritis; MS = multiple sclerosis; SG = secondary glaucoma. No patients with bilateral blind eyes were found.

these results with the risk of developing SG in phakic children at 5 years of follow-up, we find no major differences. However, this issue can be investigated only in a randomized study in which half of the children with cataract would undergo surgery and the other half would not, which is not feasible. Whether the risk of SG after cataract surgery is related to surgical techniques, IOL implantation, or anterior vitrectomy is a subject for further study.

Previously, we reported that SG was one of the major causes of blindness in children with uveitis.<sup>1</sup> In our study, one third of the blind eyes were caused by SG, which emphasizes the seriousness of this complication. However, the number of blind eyes, which is roughly 7% (11/147) of the total population, was much less compared with that of the study of Kanski and Shun-Shin.<sup>2</sup> Explanations for this decrease of visual loss among children with uveitis may be the introduction of new glaucoma medications, improved surgical techniques, or better immunosuppressive treatments of uveitis. Furthermore, one should always be aware of the risk of amblyopia developing in children with uveitis. In our series, none of the blind eyes was caused by amblyopia.

New specialized research tools, such as optic nerve head or nerve fiber layer analysis by optical coherence tomography and central corneal thickness measurement, are very important for monitoring and detecting elevated IOP in children with uveitis. However, because of the retrospective character of our study, these new techniques were neither performed systematically nor available. Optical coherence tomography is a relatively easy and quick research method, and therefore is very suitable for investigating children. The value of optical coherence tomography and central corneal thickness in IOP in children has to be determined, but we would certainly consider using these new techniques for all children with OHT and SG in the future. Visual field testing is not easy to perform in children. Especially in young children, the compliance during visual field

testing is low. For the future, we are planning to use more fully automated visual field testing. We used the van Herick technique to evaluate the anterior chamber depth, which is easy to perform in children.

In conclusion, the most important risk factor for the development of SG in pediatric uveitis is JIA, in addition to ANA-positive uveitis without evidence of arthritis. We recommend that IOP always be measured and regularly checked in all children with uveitis.

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Hypertension According to Periocular Steroid Injections

(n = 137)		5-yr Follow-up (n = 109)				10-yr Follow-up (n = 57)			
Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)
5 (11)	16 (36)	27	8 (30)	3 (11)	11 (41)	20	5 (25)	6 (30)	11 (55)
7 (6)	24 (20)	82	8 (10)	13 (16)	21 (26)	37	3 (8)	5 (14)	8 (22)
0.233	0.033			0.756	0.134			0.342	0.003

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Table 5. Elevated Intraocular Pressure, Secondary Glaucoma, and Ocular

	6-mo Follow-up (n = 147)				1-yr Follow-up (n = 133)				3-yr Follow-up	
	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)
JIA	35	4 (11)	1 (3)	5 (14)	33	4 (12)	1 (3)	5 (15)	29	7 (24)
Toxoplasmosis	12	1 (8)	0*	1 (8)	11	0 (0)	1 (10)	1 (9)	9	0
Sarcoidosis	3	0*	0*	0*	3	0*	0*	0*	3	0
MS	1	0*	0*	0*	1	0*	0*	0*	1	0
Herpes	4	1*	0*	1*	4	1*	0*	1*	2	0
Fuchs' uveitis syndrome	5	0*	0*	0*	4	0*	0*	0*	4	0
Unknown	78	12 (15)	2 (3)	14 (18)	69	15 (22)	2 (3)	17 (25)	44	10 (23)
Others <sup>†</sup>	9	0*	0*	0*	8	0*	0*	0*	5	0

JIA = juvenile idiopathic arthritis; MS = multiple sclerosis; NA = not applicable.

\*If the divisor is less than 10, no percentages are shown.

<sup>†</sup>Others: tubulointerstitial nephritis and uveitis (n = 2), chronic infantile neurological cutaneous and articular/neonatal onset multisystem inflammatory 1), toxic (n = 1), and trauma (n = 1).

Hypertension According to Underlying Cause of Pediatric Uveitis

(n = 97)		5-yr Follow-up (n = 62)				10-yr Follow-up (n = 31)			
Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)	Total n	Ocular Hypertension, n (%)	Secondary Glaucoma, n (%)	Elevated Intraocular Pressure, n (%)
4 (14)	11 (38)	24	3 (13)	9 (38)	12 (50)	12	1 (8)	4 (33)	5 (42)
1*	1*	5	0*	1*	1*	2	0*	0*	0*
0*	0*	2	0*	0*	0*	2	1*	0*	1*
0*	0*	1	0*	0*	0*	1	0*	0*	1*
0*	0*	1	0*	0*	0*	1	0*	0*	0*
0*	0*	2	0*	0*	0*	0	NA	NA	NA
3 (7)	13 (30)	27	6 (22)	3 (11)	9 (33)	13	2 (15)	3 (23)	5 (38)
0*	0*	0	NA	NA	NA	0	NA	NA	NA

disease syndrome (n = 2), psoriasis (n = 1), acute multifocal placoid pigment epitheliopathy (n = 1), diffuse unilateral subacute neuroretinitis (n =