Table 5 Relationship between mean blur rate and Heidelberg retina tomograph II parameters

	Disc MA		Disc MV		Disc MT	
	r	*P*	*r*	*P*	*r*	*P*
Disc area	0.0431	0.7971	0.3086	0.0594	−0.0922	0.5821
Cup area	**0.3637**	**0.0248**	0.0477	0.7760	**−0.5616**	**0.0002**
Rim area	**0.5588**	**0.0003**	**0.3300**	**0.0431**	**0.6534**	**<0.0001**
Cup/Disc area ratio	**−0.5437**	**0.0004**	−0.1979	0.2337	**−0.7116**	**<0.0001**
Rim/Disc area ratio	**0.5437**	**0.0004**	0.1979	0.2337	**0.7116**	**<0.0001**
Cup volume	**−0.3636**	**0.0248**	−0.0760	0.6504	**−0.4831**	**0.0021**
Rim volume	**0.3430**	**0.0350**	0.1134	0.4978	**0.4969**	**0.0015**
Mean cup depth	−0.1848	0.2667	−0.1542	0.3555	−0.1805	0.2782
Maximum cup depth	−0.1737	0.2970	**−0.3334**	**0.0408**	0.0381	0.8204
Height variation contour	**−0.4261**	**0.0076**	**−0.3365**	**0.0388**	**−0.3875**	**0.0162**
Cup shape measure	−0.3017	0.0657	−0.0224	0.8939	**−0.4747**	**0.0026**
Mean RNFL thickness	**0.4096**	**0.0106**	0.1852	0.2657	**0.4606**	**0.0036**
RNFL cross-sectional area	**0.4418**	**0.0055**	0.2518	0.1272	**0.4523**	**0.0044**
Horizontal cup/disc ratio	−0.2344	0.1567	−0.0984	0.5567	−0.2386	0.1491
Vertical cup/disc ratio	**−0.6208**	**<0.0001**	**−0.3226**	**0.0482**	**−0.6438**	**<0.0001**

Notes: Data are described in each column; r = correlation coefficient between mean deviation slope and each clinical parameter; *P* = statistical significanc; bold signifies statistically significant values.

Abbreviations: RNFL, retinal nerve fiber layer; disc MA, mean blur rate in all area of the optic disc; disc MA, mean blur rate in all area of the optic disc; disc MT, mean blur rate in tissue area of the optic disc.

association between HRT II parameters and the Humphrey field analyzer mean deviation.[23] Furthermore, we found that the generalized enlargement disc type was significantly more common than the other disc types in patients with severe high-tension glaucoma in our hospital-based study.[24] These data prompted us to focus on patients with the generalized enlargement disc type.

The disc MA was significantly associated with the degree of visual field damage in patients with glaucoma. Mean blur rate represented blood flow[36] and was strongly and positively correlated with the degree of visual field damage ($r = 0.6010$, $P = 0.0001$). Decreased blood flow has previously been demonstrated in patients with glaucoma using fluorescein angiography,[37–40] color Doppler flowmetry,[41] and scanning laser Doppler flowmetry.[42] In a rabbit model of vascular dysfunction using intravitreal administration of endothelin-1, the endothelin-1-induced decrease in mean blur rate in the optic disc led to cupping after 1 month.[43] In our human study, the mean blur rate showed a high correlation with the Humphrey field analyzer mean deviation, which suggests that LSFG-NAVI, like OCT and HRT II, is a suitable device for assessment of patients with glaucoma.

When we examined the associations between disc MV and disc MT with the other parameters, the disc MT showed stronger correlations than did the disc MV. When we separated the optic nerve head into the nerve fiber layer, lamina cribrosa, and prelaminar region, it was evident that the vasculature of the nerve fiber layer fed from the branch of the central retinal artery. The vasculature of the prelaminar region and lamina cribrosa fed from the post-ciliary artery.[44] These data suggest that the vessel mean is composed of the retinal central artery and vein, and the tissue mean is composed of the post-ciliary artery. On the other hand, for the HRT II disc parameters, only the rim area, maximum cup depth, height variant contour, and vertical cup/disc area ratio were associated with the disc MV, and this association was weak. Taken together, the stronger associations between the disc MT and the other cupping parameters from HRT II provide support for the important contribution of the post-ciliary artery to the pathogenesis of optic neuropathy in patients with glaucoma.

Here, the correlation between mean blur rate and average peripapillary retinal nerve fiber layer thickness ($r = 0.7546$) was stronger than that between mean blur rate and Humphrey field analyzer mean deviation ($r = 0.6010$) in patients with the generalized enlargement disc type of glaucoma. Generally, decreased retinal nerve fiber layer thickness is preceded by decreased Humphrey field analyzer mean deviation in the glaucoma disease process.[10] It would be interesting to study further whether the higher association between mean blur rate and average peripapillary retinal nerve fiber layer thickness indicates that blood flow also shows abnormalities, like the retinal nerve fiber layer thickness (ie, whether decreased

blood flow in the optic disc can be detected earlier than visual field loss) in the glaucoma disease process.

In conclusion, mean blur rate with LSFG-NAVI in patients with the generalized enlargement disc type of glaucoma provided valuable information, and the parameters studied correlated with retinal nerve fiber layer thickness, cupping parameters, and visual function.

Disclosure

This manuscript was presented and nominated as one of the top ten best presentations at the Japanese Glaucoma Society meeting in 2010. The abstract was published in the International Glaucoma Review meeting report (IGR December 12–13, 2010). The authors report no conflicts of interest in this work.

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CASE REPORT

Over 10 years follow-up of Coats' disease in adulthood

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Abstract: Coats' disease diagnosed in adulthood is rare; therefore, the treatment options and longer clinical course are not well established. We report on two cases of adult onset Coats' disease, which have been observed for more than 10 years after conventional treatment. In the first case, a 76-year-old man with 9 years of diabetic retinopathy noticed a visual field defect in his left eye. Yellowish subretinal exudation with serous retinal detachment in his superior peripheral retina, and telangiectatic vessels with fluorescein leakage, numerous microaneurysms, and areas of capillary nonperfusion observed in a fluorescein angiography indicated adult Coats' disease, and retinal photocoagulation was applied. Within 1 year, subretinal exudation was regressed and visual acuity was improved from 20/50 to 20/20, and was maintained for the next 11 years. In the second case, a 71-year-old man presented with decreased vision in his right eye. The fundus of his right eye showed multiple telangiectasic vessels and subretinal exudates extended to the fovea, which is diagnosed as adult Coats' disease. Despite retinal photocoagulation, an increase of exudation and an enlargement of retinal detachment was observed within 1 month, and subsequently, additional treatment of cryotherapy was performed. Two months after these therapies, the exudation was regressed without retinal detachment, and visual acuity was improved to 20/200 which was maintained for the next 10 years. Even with adult Coats' disease, conventional therapies of retinal photocoagulation and cryotherapy are effective and are the initial choice for improving or maintaining visual function.

Keywords: adult onset, Coats' disease, treatment, follow-up

Introduction

Coats' disease was first described by George Coats in 1908,[1] and is characterized by the formation of telangiectatic and aneurismal changes of the retinal vessels and is associated with a large amount of yellowish intraretinal and subretinal exudates.[2] It is predominantly unilateral occurring mostly in young males under the age of 5 years, and can cause severe visual loss resulting from exudative retinal detachment.[3]

Less commonly, Coats' disease presents in adulthood. The mean age at the time of diagnosis is approximately 50 years, and it progresses at a slower rate, but with similar features.[4] Although various methods have been employed to treat Coats' disease, including diathermy, retinal photocoagulation, cryotherapy, and vitreous surgery to elucidate the abnormal vessels, thereby minimizing exudation, the prognosis of visual function remains unsatisfactory.[5] However, only a few cases of the clinical course of adult Coats' disease after treatment have been reported.

In this article, we report the long-term follow-up of two cases of rapidly progressive Coats' diseases diagnosed over the age of 60 years with more massive and/or extensive

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http://dx.doi.org/10.2147/OPTH.S27938

lipid exudates close to the macular area. In these cases successful treatment with conventional therapy of retinal photocoagulation and/or cryoretinopexy improved Coats' disease and allowed the patients to keep their visual function for more than 10 years.

Case 1

A 76-year-old man noticed a visual field defect and decreased vision of 20/50 in his left eye. He had a history of diabetic retinopathy diagnosed 9 years before (at age of 67) and focal retinal photocoagulation had been applied and observed every year without any visual disturbance. At the initial visit (Figure 1A), fundus examination revealed thick subretinal exudates extended to and threatening the fovea, and fluorescein angiography (FA) showed telangiectatic vessels with fluorescein leakage, numerous microaneurysms, and areas of capillary nonperfusion. An optical coherence tomography (OCT) indicated an exudative retinal detachment, which is a hallmark of advanced Coats' disease.[6] He was diagnosed as having Coats' disease at age 76. Laser photocoagulation was applied to the vascular lesion, and then subretinal exudates were gradually regressed. At 1 year after the treatment, visual acuity improved to 20/20, and abnormal retinal vessels and subretinal exudates were significantly regressed. FA indicated marked reduction of fluorescein leakage from abnormal retinal vessels compared to the previous status, and OCT presented a disappearance of exudative retinal detachment (Figure 1B).

At a follow-up 11 years after the treatment for Coats' disease, subretinal exudation was minimized with retinal atrophy and visual acuity in his left eye remained at 20/20 (Figure 1C).

Case 2

A 71-year-old man was referred to our hospital due to visual impairment in his right eye despite successful cataract surgery. He noticed visual disturbance 3 years before the surgery. At his initial visit, the best-corrected visual acuity of his right eye was 12/20 and the fundus examination and FA revealed severe lipid exudation and multiple telangiectatic vessels found on the overall retina with exudative retinal detachment (Figure 2A). A clinical diagnosis of Coats' disease was made and laser photocoagulation was applied to all telangiectatic vessels. However, it was difficult to inhibit aggravation of the disease condition, and visual acuity worsened to 8/200. Thus, additional treatment of cryotherapy

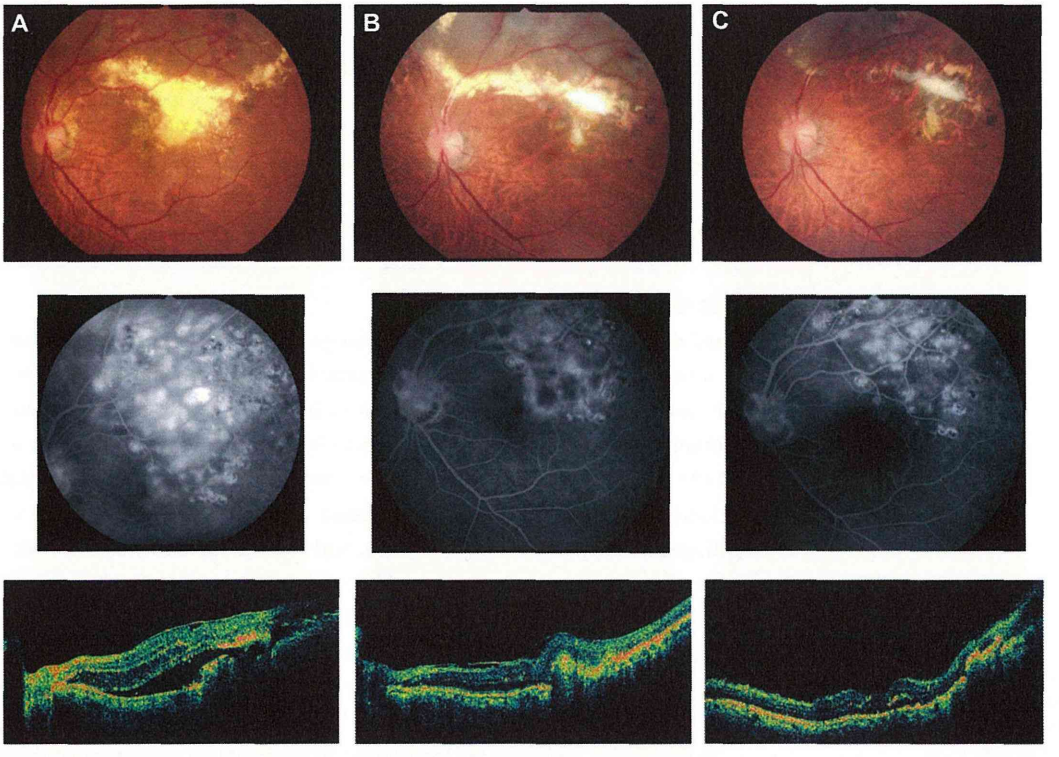

Figure 1 Color fundus photograph (upper panel), corresponding fluorescein angiography (middle), and optical coherence tomography (lower) of the left eye in patient #1 with adult Coats' disease: (**A**) at the initial visit; (**B**) 1 year after treatment of retinal photocoagulation; (**C**) 11 years after treatment.

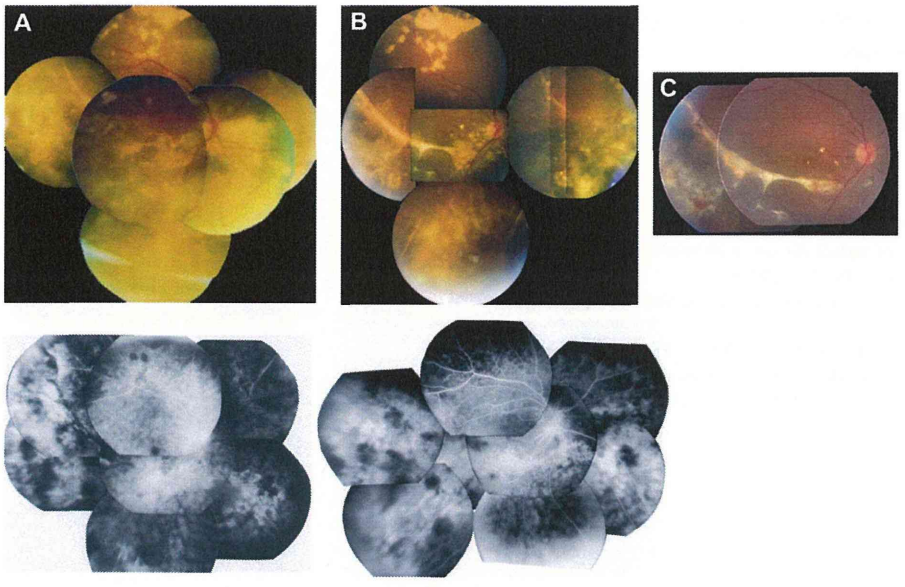

Figure 2 Color fundus photograph (upper panel), corresponding fluorescein angiography (lower) of the right eye in patient #2 with adult Coats' disease. (**A**) At the initial visit; (**B**) 3 months after treatment of retinal photocoagulation and cryotherapy; (**C**) 10 years after treatment (FA image not available).

was performed 1 month after the photocoagulation. Three months after that, lipid exudation was settled with the disappearance of exudative detachment, and visual acuity improved to 20/200 (Figure 2B). At a follow-up 10 years after the treatment, subretinal exudation was diminished and the right VA remained at 20/200 (Figure 2C).

Comments

According to several studies,[2–7] the progression of Coats' disease is relatively slow in older children or adults, and it shows indolent clinical features. The adult cases are often asymptomatic and the extent of exudation and retinal detachment tends to be mild and limited; however, the involvement of the macula as a result of subretinal exudates or exudative retinal detachment can produce poor visual acuity. Although diabetes mellitus was associated with case #1, clinical features and clinical course were typical Coats' disease. Visual prognosis in the long timespan of the follow-up (more than 10 years) showed poor results including visual acuity change from 20/40 to 4/200 over 15 years, and 20/30 to 20/70 over 11 years.[4]

Although clinical treatments for adult onset Coats' disease are not well established due to the low number of cases, ablation of abnormal retinal vessels either by laser photocoagulation or by cryotherapy are adopted in clinical situations. In this case report, intensive therapy of photocoagulation and cryoretinopexy to vascular lesions was effective enough to reduce or remove the exudative changes, and more importantly, have suppressed the worsening or recurrence of exudation for more than 10 years. Thus, these therapies were able to either improve or stabilize vision in both cases. Laser photocoagulation in the early stages, either alone, or in combination with cryotherapy, has proven to be effective especially in cases of the young. In case #1, prompt photocoagulation after decreased vision, similar to treatment in Coats' disease of the young, resulted in a good visual prognosis for a long time, which indicated that prompt treatment and careful follow-up in adult-onset Coats' disease are crucial for the preservation of visual function. Even in case #2, although conventional therapies were effective for inhibition of worsening visual function, final visual acuity of 20/200 was not satisfactory, and earlier treatment before vision deteriorates might lead to better visual prognosis. In addition, more powerful treatment options such as recently successful treatments using a combination therapy of photodynamic therapy (PDT) and intravitreal bevacizumab injection (IVB) for severe adult Coats' disease have been reported for a better visual prognosis.[8] Unfortunately, both PDT and IVB were not available in 1997, but in the future, such a treatment option may help patients similar to those in case #2.

In conclusion, we have presented two cases of rapidly progressive adult onset Coats' disease with exudative retinal detachment and massive and/or extensive lipid exudates. For these cases, conventional therapies were confirmed as effective and useful treatments to maintain visual function

not only for the short term but also for longer clinical courses of more than 10 years.

Disclosure

The authors report no conflicts of interest in this work.

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REPLY

WE APPRECIATE THE INSIGHTFUL COMMENTS OF DR OH concerning our article, in which we describe the correlation between the recovery of foveal microstructure and visual function after macular hole (MH) closure.[1] We reported that the presence of photoreceptor inner/outer segment (IS/OS) junction was correlated with good visual recovery after MH surgery.[2] Using spectral-domain optical coherence tomography (OCT), we found that the restoration of external limiting membrane (ELM) is closely associated with that of the IS/OS junction.[1]

Dr Oh provided additional points of view concerning our observations. He pointed out that change in foveal contour such as thickening or widening of the foveal center, which was observed on the serial OCT images in our Figure 3, may be the result of the regeneration or rearrangement of retinal layers. In reply to this comment, we re-examined the postoperative OCT images in our study and investigated the relationship between central foveal thickness (CFT) and length of IS/OS junction or ELM defect. There was a significant negative relationship between postoperative CFT and postoperative IS/OS junction defect ($r = -0.37$, $P = .0173$; $r = -0.40$, $P = .0099$; $r = -0.53$, $P = .0006$; at 1, 3, and 6 months, respectively). The correlation between postoperative CFT and ELM defect was significant only at 1 month ($r = -0.38$, $P = .0138$). These data suggest that IS/OS junction or ELM restoration is accompanied by foveal thickening. The reason for the absence of correlation between CFT and ELM defect at 3 and 6 months may be because ELM defect was 0 μm in most eyes at these times. There was no significant correlation between postoperative CFT and visual acuity ($P > .05$ for all), which was consistent with the previous report.[3] The visual outcome may not be dependent on CFT, but rather on the IS/OS junction or ELM restoration.

In traumatic MH, we reported a bridge formation of the tissue, which mimicked foveal detachment, in the process of spontaneous MH closure.[4] In our study, we observed foveal detachment in 28% of eyes at 1 month, 12% at 3 months, and 7% at 6 months. There was no significant difference of IS/OS junction or ELM defect between eyes with and without foveal detachment at each observation point ($P > .05$ for all).

We agree with Dr Oh's comment that changes in foveal contour also were influenced by the factor that the serial images may not have been obtained exactly in the same location. Bottoni and associates analyzed changes of the outer retina after MH repair using Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany) with the AutoRescan function, which automatically guides the OCT instrument to scan the same location.[5] However, there may be a slight variation of the position in their serial images, as also pointed by the authors. We also agree with the comment that "3 or 6 months seems too short of a time for the outer foveolar defect to be healed completely." It has been reported that outer foveolar defect was observed in one third of the eyes at 12 months.[6] In our study, we found incomplete restoration of IS/OS junction in 70% at 6 months. Thus, further studies to evaluate the recovery of foveal microstructure for a longer period are needed.

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Conflict of Interest Disclosures: See the original article[1] for any disclosures of the authors.

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Miami to Japan Eye-Care Rescue Mission: Vision Van Helps with Relief Efforts

EDITOR:

THE DEVASTATING EARTHQUAKE OF MARCH 11—THE BIGgest disaster of modern Japan—hit the northeastern part of the island nation; the subsequent tsunami struck and destroyed almost all coastal villages and cities, leaving

more than 20 000 either dead or missing.[1] The destruction was so severe that communication infrastructures and transportation systems were disabled, leading to challenges for rescue and recovery as well as lack of supplies and gasoline. Thousands of survivors were homeless and without immediate medical care.

As reported in Haiti, a quick rescue response is critical.[2] However, in this case, eye care needs were considered minor given the magnitude of this disaster. Yet, many survivors lost their eyeglasses or medicines. A complete eye examination requires basic ophthalmic instruments, so a visit by an ophthalmologist with minimal instrumentation may not be effective. Thus, we sought to deliver urgent eye care with a mobile vision care facility.

The media in the United States had reported the use of Bascom Palmer Eye Institute's Vision Van in New Orleans after Hurricane Katrina in 2005 to aid in the treatment of visual casualties.[3] This van is equipped with modern specialized eye instrumentation necessary for examinations. Arrangements were made to borrow the van, and the initial challenge of transporting the van was overcome through the offer from Volga-Dnepr Airlines for the use of the Anotov An-124—the world's largest cargo airplane. This international assistance made it possible to transport the Vision Van from Miami to Sendai Airport, where it began rotating between Iwate and Miyagi prefectures, visiting evacuation centers in coastal cities on a weekly rotation. Volunteer ophthalmologists simply go to the care site and provide eye care to the evacuees in these remote areas. Additionally, care for chronic eye disorders such as diabetic retinopathy, glaucoma, and age-related macular degeneration is necessary to preserve vision and prevent further vision loss. During the first 12 clinic days of the Vision Van's rotation, 567 patients were seen, averaging 47 patients per day. Overall, the primary eye-related trouble for evacuees has been the loss of eyeglasses and treatment for pre-existing conditions.

The international collaboration involved in this ambitious endeavor was successful. Mobile vans are useful in such situations, and we would like to propose to world leaders that emergent medical systems be prepared as a precaution. Initially, the *Mission Vision Van* seemed impossible, but became *Mission Possible* through the efforts of many, and for that, we are most grateful.

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The authors thank the University of Miami Miller School of Medicine, Volga-Dnepr Airlines, MediProduce, Inc, and the Japanese government for their support of the Mission Vision Van project and are deeply indebted to all the health care professionals who are volunteering their time and skills to see patients displaced by the tsunami.

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Tsubota is a consultant to AcuFocus, Thea Lab, and Bausch & Lomb Surgical; receives lecture fees from Santen Pharmaceuticals; has patent interests for the Functional Visual Acuity Meter and with Rainbow Optical; and has received travel expenses from Santen Pharmaceuticals. Dr Tsubota's institution, The Keio University School of Medicine, has received financial support from Santen Pharmaceuticals, the Japanese Ministry of Education, Kissei, Kowa, and Wakasa Seikatsu Co, Ltd, and has received lecture fees from Santen Pharmaceuticals. No conflicts of interest were reported by the other authors.

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Success Rates of Trabeculotomy for Steroid-Induced Glaucoma: A Comparative, Multicenter, Retrospective Cohort Study

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• PURPOSE: To evaluate the surgical outcomes of trabeculotomy for steroid-induced glaucoma.

• DESIGN: Multicenter, retrospective cohort study.

• METHODS: At 17 Japanese clinical centers, 121 steroid-induced glaucoma patients who underwent trabeculotomy between 1997 and 2006 were reviewed. Surgical failure was defined by the need for additional glaucoma surgery, deterioration of visual acuity to no light perception, or intraocular pressure ≥21 mm Hg (criterion A) and ≥18 mm Hg (criterion B). Surgical outcomes were compared with those of 108 primary open-angle glaucoma (POAG) patients who underwent trabeculotomy and 42 steroid-induced glaucoma patients who underwent trabeculectomy. Prognostic factors for failure were evaluated using the Cox proportional hazards model.

• RESULTS: The probabilities of success at 3 years for trabeculotomy for steroid-induced glaucoma vs trabeculotomy for POAG was 78.1% vs 55.8% for criterion A ($P = .0008$) and 56.4% vs 30.6% for criterion B ($P < .0001$), respectively. At 3 years, the success of trabeculotomy for steroid-induced glaucoma was comparable to trabeculectomy for steroid-induced glaucoma for criterion A (83.8%; $P = .3636$), but lower for criterion B (71.6%; $P = .0352$). Prognostic factors for failure of trabeculotomy for steroid-induced glaucoma were previous vitrectomy (relative risk [RR] = 5.340; $P = .0452$ on criterion A, RR = 3.898; $P = .0360$ for criterion B) and corticosteroid administration other than ocular instillation (RR = 2.752; $P = .0352$ for criterion B).

• CONCLUSIONS: Trabeculotomy is effective for controlling intraocular pressure <21 mm Hg in steroid-induced glaucoma eyes. (Am J Ophthalmol 2011;151: 1047–1056. © 2011 by Elsevier Inc. All rights reserved.)

Accepted for publication Nov 26, 2010.

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STEROID-INDUCED GLAUCOMA IS A FORM OF OPEN-angle glaucoma associated with various modalities of corticosteroid administration such as oral, intravenous, inhaled, ocular instilled, intravitreal, and periocular.[1–6] Some histologic studies have reported the accumulation of extracellular matrices including basement membrane–like material,[7–9] fine fibrillar-like material,[8] or proteoglycans[9] in the trabecular meshwork of steroid-induced glaucoma patients. These observations suggest that such accumulation could lead to an increased resistance to aqueous outflow in the trabecular meshwork of steroid-induced glaucoma patients.

Surgical procedures for intraocular pressure (IOP) reduction in eyes with steroid-induced glaucoma include trabeculectomy,[2,10,11] trabeculotomy,[4,12] viscocanalostomy,[13] and laser trabeculoplasty.[14–18] Although several case series have shown that these surgeries are effective for IOP reduction, surgical outcomes for steroid-induced glaucoma are not fully understood due to lack of large case-control studies aiming to investigate the success rates of trabeculotomy in steroid-induced glaucoma eyes. It has previously been reported that trabeculotomy more effectively reduces IOP in adult Japanese patients with exfoliative glaucoma than primary open-angle glaucoma (POAG).[19] This IOP-lowering effect in eyes with exfoliative glaucoma is thought to be attributable to the relief of abnormally increased outflow resistance that was induced by the accumulation of exfoliative material within the trabecular meshwork.

For the same reason, trabeculotomy has been the surgical procedure of choice for adult patients with steroid-induced glaucoma among Japanese surgeons.[20] We previously showed that trabeculotomy helped to reduce IOPs to 21 mm Hg or less in 14 Japanese patients with steroid-induced glaucoma.[12] However, large-scale, comparative clinical data remain elusive on, for example, whether trabeculotomy is more effective for steroid-induced glaucoma than POAG, whether trabeculotomy for steroid-induced glaucoma offers better IOP management than other surgeries such as trabeculectomy with mitomycin C (MMC), or which characteristics of patients with steroid-induced glaucoma exhibit better prognosis after trabeculotomy. To evaluate the surgical outcomes of trabeculotomy for steroid-induced

0002-9394/$36.00
doi:10.1016/j.ajo.2010.11.028