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Follow-up after intravitreal triamcinolone acetonide for diabetic macular edema

J.B. JONAS, U.H. SPANDAU, B.A. KAMPPETER, U. VOSSMERBAEUMER, B. HARDER

Department of Ophthalmology, Faculty of Clinical Medicine, Mannheim, Univ. Heidelberg, Heidelberg - Germany

PURPOSE. *To report on the follow-up of patients who received an intravitreal high-dosage injection of triamcinolone acetonide (IVTA) as treatment of diffuse diabetic macular edema.*
METHODS. *The clinical interventional case-series study included 109 eyes (90 patients) with diffuse diabetic macular edema who consecutively received an IVTA of about 20 mg. Mean follow-up was 11.2 ± 6.2 months.*
RESULTS. *Visual acuity improved significantly ($p<0.001$) from 0.89 ± 0.33 logMAR to a best minimum of 0.65 ± 0.35 logMAR. An increase in best visual acuity by at least 1 Snellen line, 2 lines, and 3 lines was found in 91 (83%) eyes, 68 (62%) eyes, and 45 (41%) eyes, respectively. Differences in visual acuity between baseline and follow-up examinations were significant for measurements performed at 1 month ($p<0.001$), 2 months ($p<0.001$), 3 months ($p<0.001$), and at 6 months ($p=0.001$) after the injection. At 9 months after the injection, mean visual acuity regressed significantly so that visual acuity at 9 months ($p=0.83$) and at 12 months after the injection ($p=0.58$) compared with baseline values did not differ significantly. Forty-seven (43%) eyes developed a rise in intraocular pressure (pressure >21 mmHg) for 6 to 8 months after the injection. No other severe complications were detected.*
CONCLUSIONS. *The duration of a visual acuity increase and intraocular pressure rise after high-dosage IVTA in diffuse diabetic macular edema is about 6 to 8 months. Compared with data in the literature, the high-dosage IVTA may not have a markedly higher profile of side effects than low-dosage IVTA. (Eur J Ophthalmol 2006; 16: 566-72)*

KEY WORDS. *Intravitreal triamcinolone acetonide, Intravitreal steroids, Diabetic macular edema, Intraocular pressure, Diabetic retinopathy*

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INTRODUCTION

Based on the pioneering studies by Robert Machemer on the intraocular application of steroids, diabetic macular edema has increasingly been treated by intravitreal injections of triamcinolone acetonide, using the anti-edematous and anti-angiogenic properties of the drug (1-25).

These studies have suggested that the intravitreal injection of triamcinolone acetonide may be a treatment option if other treatment modalities have failed or are not available. For most of these investigations, the follow-up was relatively short so that data for a longer follow-up have mostly not been available. Additionally, most investigators have used a dosage of 4 mg of triamcinolone acetonide, while the high dosage of about 20 mg has been applied in few studies.

Since the risk of side effects usually increases with the dosage of a drug, it was the purpose of the present investigation with the application of the high dosage of intravitreal triamcinolone acetonide to assess the change in visual acuity and intraocular pressure for a larger number of patients with a follow-up longer than reported so far, to increase the information on safety issues of the high-dosage therapy, and to evaluate the duration of the effects and side effects of the treatment.

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TABLE I - VISUAL ACUITY AT BASELINE AND DURING FOLLOW-UP IN 109 EYES RECEIVING A SINGLE INTRAVITREAL INJECTION OF ABOUT 20 MG TRIAMCINOLONE ACETONIDE AS TREATMENT OF DIFFUSE DIABETIC MACULAR EDEMA

Visual acuity	n	Mean ± SD	Median	p Value
Baseline				
Snellen	109	0.17 ± 0.13	0.12	—
LogMAR		0.89 ± 0.33	0.90	—
1 Month				
Snellen	92	0.23 ± 0.18	0.20	<0.001
LogMAR		0.75 ± 0.70	0.70	<0.001
Change (Snellen lines)		1.23 ± 2.36	1	
Change (LogMAR)		-0.12 ± 0.23	-0.103	
Gain 3 Snellen lines		24/92 (23%)		
Loss 3 Snellen lines		4/92 (4%)		
2 Months				
Snellen	84	0.24 ± 0.20	0.20	<0.001
LogMAR		0.73 ± 0.32	0.70	<0.001
Change (Snellen lines)		1.43 ± 3.26	1	
Change (LogMAR)		-0.15 ± 0.23	-0.12	
Gain 3 Snellen lines		27/84 (32%)		
Loss 3 Snellen lines		5/84 (6%)		
3 Months				
Snellen	89	0.23 ± 0.16	0.20	<0.001
LogMAR		0.77 ± 0.40	0.70	<0.001
Change (Snellen lines)		1.28 ± 2.5	1	
Change (LogMAR)		-0.12 ± 0.27	-0.10	
Gain 3 Snellen lines		25/89 (28%)		
Loss 3 Snellen lines		4/89 (5%)		
6 Months				
Snellen	80	0.22 ± 0.16	0.20	0.001
LogMAR		0.78 ± 0.32	0.70	0.001
Change (Snellen)		0.97 ± 2.71	1	
Change (LogMAR)		-0.10 ± 0.27	-0.10	
Gain 3 Snellen lines		19/80 (24%)		
Loss 3 Snellen lines		7/80 (9%)		
9 Months				
Snellen	55	0.17 ± 0.13	0.10	0.25 (NS)
LogMAR		0.91 ± 0.42	1.00	0.83 (NS)
Change (Snellen)		-0.40 ± 3.05	0	
Change (LogMAR)		0.00 ± 0.37	0.00	
Gain 3 Snellen lines		11/55 (20%)		
Loss 3 Snellen lines		10/55 (18%)		
12 Months				
Snellen	52	0.14 ± 0.10	0.10	0.86 (NS)
LogMAR		0.97 ± 0.2	1.00	0.58 (NS)
Change (Snellen)		-0.40± 3.05	0	
Change (LogMAR)		0.04 ± 0.30	0.00	
Gain 3 Snellen lines		7/52 (13%)		
Loss 3 Snellen lines		12/52 (23%)		
End of follow-up				
Snellen	109	0.18 ± 0.15	0.10	0.26 (NS)
LogMAR		0.89 ± 0.38	1.00	0.69 (NS)
Change (Snellen)		-0.11± 3.38	0	
Change (LogMAR)		0.00 ± 0.33	0.00	
Gain 3 Snellen lines		20/109 (18%)		
Loss 3 Snellen lines		20/109 (18%)		

PATIENTS AND METHODS

The prospective interventional case-series study included 90 patients (109 eyes) (47 women; 45 right eyes) who consecutively presented with diffuse diabetic macular edema, who received an intravitreal injection of triamcinolone acetonide of about 20 mg as single and only therapeutic procedure during follow-up, and for whom the follow-up was longer than 3 months. Nineteen (21%) patients received the intravitreal cortisone injection in both of their eyes. Mean age was 66.9 ± 9.6 years (range, 28.2–85.1 years; median, 67.4 years). Refractive error ranged between –2.5 diopters and +5.25 diopters (mean ± SD: 0.52 ± 1.32 diopters; median, 0.50 diopters). Mean intraocular pressure was 15.4 ± 3.4 mmHg (range, 8–24 mmHg; median, 15 mmHg).

The diagnosis of diffuse diabetic macular as defined by the Early Treatment of Diabetic Retinopathy Study (ETDRS) was substantiated by fluorescein angiography. Diabetic macular edema diffusely involved the central fovea and persisted for at least 3 months. Focal retinal laser treatment had been performed if indicated according to the ETDRS guidelines. If laser treatment had been performed, it had been carried out 3 or more months prior to inclusion into the study. Exclusion criteria for the study were uncontrolled glaucoma, loss of vision as a result of other causes, systemic treatment with prednisolone, severe systemic disease, or any condition affecting follow-up or documentation. All patients were fully informed about the experimental character of the treatment and consent was obtained from the subjects after the nature of the procedure was explained. The Ethics Committee of the University had approved the study, which followed the tenets of the Declaration of Helsinki. History of glaucoma or of intraocular surgery including cataract surgery were not exclusion criteria.

All patients received an intravitreal injection of about 20 mg triamcinolone acetonide in 0.2 mL Ringer's solution as previously described in detail (6). A recent study revealed that using the same filtering technique as in the present study, the dosage of triamcinolone acetonide ready for intravitreal injection was about 23.8 ± 0.6 mg (26). At baseline of the study, visual acuity and intraocular pressure were determined and fluorescein angiography was performed. After inclusion into the study, the patients were re-examined the first day after the injection, followed by re-examinations at about monthly intervals for the first 3 months after the injection, and at about 3-monthly intervals thereafter. Mean follow-up was 11.2 ± 6.2 months (median, 9.7 months; range, 3.0–25.2 months). Visual acuity was determined in a standardized fashion by an observer performing best-corrected refractometry and using Snellen charts. The visual acuity measurements were given as Snellen lines and in metric units. Additionally, they were converted to the logarithm of the minimum angle of resolution (logMar). Intraocular pressure was measured by Goldmann applanation tonometry.

Statistical analyses were performed by using a commercially available statistical software package (SPSS for Windows, version 11.5, SPSS, Chicago, IL, USA). To test the statistical significance of differences between the baseline values and the measurements obtained during follow-up, the Wilcoxon test for paired samples was used.

RESULTS

For 89 (82%) eyes included in the study, 3-month data were available; for 80 (73%) eyes, data were available for the 6-month study visit; for 55 (50%) eyes, follow-up data were available for the 9-month visit; and for 52 (48%) eyes, 12-month data were assessed. For 43 (39%) eyes, examinations were performed more than 12 months after the injection.

Visual acuity improved significantly ($p<0.001$) from 0.89 ± 0.33 logMAR (median, 0.90; range 0.10 to 2.52) to a best minimum of 0.65 ± 0.35 logMAR (median, 0.60; range, 0.00 to 2.40). An increase by at least 3 Snellen lines in best visual acuity at any time during the whole follow-up was found in 45 (41%) eyes. An increase in best visual acuity during follow-up by at least two lines and at least one line was found for 68 (62%) eyes and for 91 (83%) eyes, respectively. Two (2%) eyes lost three or more lines in best visual acuity during follow-up.

Comparing preoperative visual acuity measurements with the measurements obtained at the follow-up visits, the differences were statistically significant for the measurements performed at 1 month ($p<0.001$), at 2 months ($p<0.001$), at 3 months ($p<0.001$), and at 6 months ($p=0.001$) after the injection (Tab. I). At 9 months after the injection, mean visual acuity deteriorated significantly so that visual acuity at 9 months after the injection and visual acuity at baseline of the study did not vary significantly ($p=0.83$). Correspondingly, at 12 months after the injection ($p=0.58$) and at the end of the follow-up ($p=0.69$), visual acuity measurements and baseline values did not differ significantly. Intraocular

TABLE II - INTRAOCULAR PRESSURE (MMHG) AT BASELINE AND DURING FOLLOW-UP IN 109 EYES RECEIVING A SINGLE INTRAVITREAL INJECTION OF ABOUT 20 MG TRIAMCINOLONE ACETONIDE AS TREATMENT OF DIFFUSE DIABETIC MACULAR EDEMA

Intraocular pressure	Mean ± SD	Median	p Value
Baseline	15.4 ± 3.4	15	—
1 Month	17.2 ± 4.8	18	<0.001
Change	1.9 ± 4.9	1	
2 Months	17.9 ± 4.8	17	<0.001
Change	2.4 ± 4.8	2	
3 Months	17.8 ± 4.6	18	0.001
Change	2.0 ± 4.8	2	
6 Months	17.5 ± 4.9	16	0.01
Change	1.9 ± 5.4	2	
9 Months	18.0 ± 6.1	17	0.10 (–)
Change	1.7 ± 6.3	2	
12 Months	16.6 ± 3.8	16	0.77 (–)
Change	0.5 ± 5.1	0	

pressure increased significantly ($p<0.001$; Wilcoxon test) from 15.4 ± 3.4 mmHg (median, 15 mmHg) at baseline of the study to a mean maximum of 21.4 ± 5.9 mmHg (median, 20 mmHg), and again decreased significantly ($p<0.001$) towards the end of follow-up to a mean of 16.6 ± 5.3 mmHg (median, 16 mmHg). The intraocular pressure measurements at the end of follow-up did not differ significantly ($p=0.32$) from the baseline value. Forty-seven (43%) eyes developed a maximal intraocular pressure higher than 21 mmHg during follow-up, which was treated by topical antiglaucomatous treatment.

Except for a progression of cataract, which was not assessed in the present study, no other severe complications besides the rise in intraocular pressure were detected.

DISCUSSION

Intravitreal triamcinolone acetonide has increasingly been used in previous studies as treatment for intraocular proliferative, edematous, and neovascular diseases, such as central and branch retinal vein occlusion, neovascular glaucoma without or with cataract surgery, chronic prephthisical ocular hypotony, chronic uveitis, neovascular age-related macular degeneration, and in other clinical situations (27). In aqueous humor, triamcinolone acetonide has been found 8 to 9 months after an intravitreal injection of about 20 mg in contrast to about 3 months if given in a dosage of 4 mg (28-30). Systemic and local side effects, reported so far, include cataract, secondary ocular hypertension leading in some patients to secondary chronic open-angle glaucoma, and postinjection infectious and noninfectious endophthalmitis (31-34). Interestingly, triamcinolone acetonide was not detected, or found in traces only, in the serum of patients after an intravitreal injection of 20 mg triamcinolone acetonide (35).

In previous studies, intravitreal triamcinolone acetonide has additionally been applied as treatment of diabetic retinopathy including diabetic macular edema (3-25). With these studies on intravitreal triamcinolone acetonide in general, it has been the first time that a treatment has been shown to improve vision in patients with diffuse diabetic macular edema. Previous investigations applying tissue destructive retinal laser coagulation were mainly focused on the prevention of further loss of vision (36-38). In most of the studies using intravitreal triamcinolone acetonide, a dosage of 4 mg of intravitreal triamcinolone acetonide has been used, leading to an increase in visual acuity for about 2 to 6 months, and leading to a temporary rise in intraocular pressure of about 2 to 6 months. In

agreement with these studies on a visual acuity improving effect of intravitreal triamcinolone acetonide, the present study additionally gives some information about the duration of the effect of the high dosage of triamcinolone acetonide and about the duration of the rise in intraocular pressure. Compared with the baseline of the study, the visual acuity measurements were significantly higher at the examinations performed up to 6 months after the injection (Tab. I). At 9 months and 12 months after the intervention, visual acuity significantly regressed and no longer varied from the baseline values. This suggests that the duration of the effect of intravitreal triamcinolone acetonide given in a dosage of about 20 mg was about 6 to 8 months.

The duration of the effect of the high dosage of intravitreal triamcinolone acetonide in the present study with about 6–8 months was longer than reported in studies using a dosage of 4 mg triamcinolone acetonide (5, 7, 10-23). This is in agreement with a recent study directly comparing various dosages of intravitreal triamcinolone acetonide (25). In that prospective, randomized, double masked study, three patient groups were formed receiving an intravitreal injection of triamcinolone acetonide of about 2 mg (n = 8 eyes), 5 mg (n = 10), or 13 mg (n = 9), respectively. The duration of the visual acuity improving effect of intravitreal triamcinolone acetonide increased significantly with the dosage of intravitreal triamcinolone acetonide ($r=0.45$; $p=0.014$). The amount of the rise in intraocular pressure was not significantly associated with the dosage used ($p=0.77$). From a practical point of view, this suggests that the high dosage needs fewer reinjections. Considering that the risk of an infectious endophthalmitis may depend on the procedure of the injection itself and not on the dosage, the risk for a postinjection endophthalmitis may be lower with the higher dosage.

Parallel to the temporary increase in visual acuity, intraocular pressure was significantly elevated for 6 to 8 months after the injection and returned to baseline values at 9 months after the injection. Comparing studies using different dosages of triamcinolone acetonide for intravitreal injection may suggest that the higher the dosage is, the longer is the duration of the steroid-induced ocular hypertension (5-7, 9, 10, 19-21, 27, 39-43). The frequency of secondary ocular hypertension may not directly be correlated with the dosage injected. About 40% of the eyes of the present study developed an intraocular pressure higher than 21 mmHg. That number is comparable with the results of another previous study on the high-dosage use of triamcinolone acetonide as well as with studies using the low dosage of triamcinolone acetonide (5-7, 9, 10, 19-21, 27, 39-43). In the study performed by Smithen and collaborators with the intravitreal use of 4 mg triamcinolone acetonide, a pressure elevation defined as a pressure of 24 mmHg or higher during follow-up was found in 36 (40.4%) of 89 patients at a mean of 101 ± 83 days after the injection (42). In the study carried out by Park and colleagues on 60 patients receiving 4 mg intravitreal triamcinolone acetonide, the mean intraocular pressure peaked at 2 months ($p<0.001$) after the injection (43). Twenty-six eyes (43.3%) showed a significant elevation in intraocular pressure. Interestingly, the frequency of a rise in intraocular pressure in a recent study on 32 eyes with a history of recurrent noninfectious posterior uveitis and receiving the intravitreal fluocinolone acetonide implant was 56.1% over the follow-up period compared with 11.0% at baseline of the study (44).

The present study may be too small to adequately address safety questions other than intraocular pressure. Previous investigations have shown, however, that side effects include cataract, secondary ocular hypertension leading in some patients to secondary chronic open-angle glaucoma, and postinjection infectious endophthalmitis (27, 31-34). Although not systematically evaluated in the present study, the probability for cataract surgery within 1 year after an intravitreal injection of about 20 mg triamcinolone acetonide in elderly patients was recently estimated to be about 15% to 20% if the high dosage of triamcinolone acetonide was used (34, 45). Another safety issue may be an injection-related infectious endophthalmitis, particularly because diabetes mellitus leads to an increased susceptibility to infection. The injection of an immunosuppressive drug such as triamcinolone acetonide may further increase the risk for an infectious endophthalmitis. Recent studies have suggested, however, that if the injection is carried out under sterile conditions, the rate of an infectious endophthalmitis after an intravitreal injection of triamcinolone acetonide may be about 1:500 to 1:1,000 (27, 32, 33, 46).

There are limitations to the present study. The effect of the treatment was not controlled by optical coherence tomography, which allows an objective determination of the thickness of the macula as measure of macular edema. Since, however, a decrease in macular thickness is not necessarily associated with an increase in visual acuity, the measurement of subjective visual acuity may be an alternative to monitor the effect of the therapy. In a similar manner, a change in the amount of lipid exudation into the

retinal tissue in form of hard exudates was not systematically assessed (47). But again, the more important outcome measure of the treatment may be an improvement in function as assessed with visual acuity measurements rather than an improvement in the appearance of the fundus. Another limitation of the study is that, although intravitreal triamcinolone will have increased the cataract, the progression in lens opacity was not routinely assessed. Neither was cataract surgery performed during follow-up. The vision reducing effect of progressive cataract, however, might have hidden parts of a vision-improving effect of triamcinolone.

In conclusion, the data of the present study suggest that intravitreal high-dosage triamcinolone acetonide may improve vision and increase intraocular pressure of patients with diffuse diabetic macular edema for a period of about 6 to 8 months.

The authors have no proprietary interest.

Reprint requests to:
Jost B. Jonas, MD
Universitäts-Augenklinik
Theodor-Kutzer-Ufer 1-3
68167 Mannheim, Germany
Jost.Jonas@augen.ma.uni-heidelberg.de

REFERENCES

1. Machemer R, Sugita G, Tano Y. Treatment of intraocular proliferations with intravitreal steroids. Trans Am Ophthalmol Soc 1979; 77: 171-80.
2. Machemer R. Five cases in which a depot steroid (hydrocortisone acetate and methylprednisolone acetate) was injected into the eye. Retina 1996; 16: 166-7.
3. Jonas JB, Hayler JK, Söfker A, et al. Intravitreal injection of crystalline cortisone as adjunctive treatment of proliferative diabetic retinopathy. Am J Ophthalmol 2001; 131: 468-1.
4. Jonas JB, Söfker A. Intraocular injection of crystalline cortisone as adjunctive treatment of diabetic macular edema. Am J Ophthalmol 2001; 132: 425-7.
5. Martidis A, Duker JS, Greenberg PB, et al. Intravitreal triamcinolone for refractory diabetic macular edema. Ophthalmology 2002; 109: 920-7.
6. Jonas JB, Kreissig I, Söfker A, et al. Intravitreal injection of triamcinolone acetonide for diabetic macular edema. Arch Ophthalmol 2003; 121: 57-61.
7. Massin P, Audren F, Haouchine B, et al. Intravitreal triamcinolone acetonide for diabetic diffuse macular edema: preliminary results of a prospective controlled trial. Ophthalmology 2004; 111: 218-24.
8. Jonas JB, Degenring R, Kamppeter B, et al. Duration of the effect of intravitreal triamcinolone acetonide as treatment of diffuse diabetic macular edema. Am J Ophthalmol 2004; 138: 158-60.
9. Jonas JB, Harder B, Kamppeter B. Inter-eye difference in diabetic macular edema after unilateral intravitreal injection of triamcinolone acetonide. Am J Ophthalmol 2004; 138: 970-7.
10. Audren F, Tod M, Massin P, et al. Pharmacokinetic-pharmacodynamic modeling of the effect of triamcinolone acetonide on central macular thickness in patients with diabetic macular edema. Invest Ophthalmol Vis Sci 2004; 45: 3435-41.
11. Bakri SJ, Beer PM. Intravitreal triamcinolone injection for diabetic macular edema: a clinical and fluorescein angiographic case series. Can J Ophthalmol 2004; 39: 755-60.
12. Bandello F, Pognuz DR, Pirracchio A, et al. Intravitreal triamcinolone acetonide for florid proliferative diabetic retinopathy. Graefes Arch Clin Exp Ophthalmol 2004; 242: 1024-7.
13. Ciardella AP, Klancnik J, Schiff W, et al. Intravitreal triamcinolone for the treatment of refractory diabetic macular edema with hard exudates: an optical coherence tomography study. Br J Ophthalmol 2004; 88: 1131-6.
14. Islam MS, Negi A, Vernon SA. Improved visual acuity and macular thickness 1 week after intravitreal triamcinolone for diabetic macular edema. Eye 2004 Dec. 3 (Epub ahead of print).
15. Karacorlu M, Ozdemir H, Karacorlu S, et al. Intravitreal triamcinolone as a primary therapy in diabetic macular edema. Eye 2005; 19: 382-6.
16. Lam DS, Chan CK, Tang EW, et al. Intravitreal triamcinolone for diabetic macular edema in Chinese patients: six-month prospective longitudinal pilot study. Clin Exp Ophthalmol 2004; 32: 569-72.
17. Negi AK, Vernon SA, Lim CS, et al. Intravitreal triamcinolone improves vision in eyes with chronic diabetic macular edema refractory to laser photocoagulation. Eye 2005; 19: 747-51.
18. Ozkiris A, Evereklioglu C, Erkilic K, et al. Intravitreal triamcinolone acetonide injection as primary treatment for diabetic macular edema. Eur J Ophthalmol 2004; 14: 543-9.
19. Sutter FK, Simpson JM, Gillies MC. Intravitreal triamcinolone for diabetic macular edema that persists after laser

treatment: three-month efficacy and safety results of a prospective, randomized, double-masked, placebo-controlled clinical trial. Ophthalmology 2004; 111: 2044-9.
20. Jonas JB, Kreissig I, Degenring RF, et al. Repeated intravitreal injection of triamcinolone acetonide for diffuse diabetic macular edema. Br J Ophthalmol 2005; 89:122.
21. Jonas JB, Akkoyun I, Kreissig I, et al. Diffuse diabetic macular edema treated by intravitreal triamcinolone acetonide. A comparative non-randomized study. Br J Ophthalmol 2005; 89: 321-6.
22. Krepler K, Wagner J, Sacu S, et al. The effect of intravitreal triamcinolone on diabetic macular edema. Graefes Arch Clin Exp Ophthalmol 2005; 243: 478-81.
23. Sorensen TL, Haamann P, Villumsen J, et al. Intravitreal triamcinolone for macular edema: efficacy in relation to aetiology. Acta Ophthalmol Scand 2005; 83: 67-70.
24. Jonas JB, Martus P, Degenring RF, et al. Predictive factors for visual acuity change after intravitreal triamcinolone for diabetic macular edema. Arch Ophthalmol 2005; 123: 1338-43.
25. Spandau UH, Derse M, Schmitz-Valckenberg P, et al. Dosage-dependency of intravitreal triamcinolone acetonide as treatment for diabetic macular edema. Br J Ophthalmol 2005; 89: 999-1003
26. Spandau UH, Derse M, Schmitz-Valckenberg P, et al. Measurement of triamcinolone acetonide concentration after filtering of solvent agent. Am J Ophthalmol 2005; 139: 712-3.
27. Jonas JB, Kreissig I, Degenring RF. Intravitreal triamcinolone acetonide for treatment of intraocular proliferative, exudative and angiogenic diseases. Prog Retin Eye Res 2005; 5: 587-611.
28. Jonas JB. Concentration of intravitreally applicated triamcinolone acetonide in aqueous humour. Br J Ophthalmol 2002; 86: 1066.
29. Jonas JB. Intraocular availability of triamcinolone acetonide after intravitreal injection. Am J Ophthalmol 2004; 137: 560-2.
30. Beer PM, Bakri SJ, Singh RJ, Liu W, Peters GB 3rd, Miller M. Intraocular concentration and pharmacokinetics of triamcinolone acetonide after a single intravitreal injection. Ophthalmology 2003; 110: 681-6.
31. Wingate RJ, Beaumont PE. Intravitreal triamcinolone and elevated intraocular pressure. Aust NZ J Ophthalmol 1999; 27: 431-2.
32. Benz MS, Murray TG, Dubovy SR, et al. Endophthalmitis caused by Mycobacterium chelonae abscessus after intravitreal injection of triamcinolone. Arch Ophthalmol 2003; 121: 271-3.
33. Gillies MC, Simpson JM, Billson FA, et al. Safety of an intravitreal injection of triamcinolone: results from a randomized clinical trial. Arch Ophthalmol 2004; 122: 336-40.
34. Gillies M, Kuzniarz M, Craig J, et al. Intravitreal triamcinolone-induced elevated intraocular pressure is associated with the development of posterior subcapsular cataract. Ophthalmology 2005; 112: 139-43.
35. Degenring RF, Jonas JB. Serum levels of triamcinolone acetonide after intravitreal injection. Am J Ophthalmol 2004; 137: 1142-3.
36. Early Treatment Diabetic Retinopathy Study Research Group. Early photocoagulation for diabetic retinopathy. ETDRS report number 9. Ophthalmology 1991; 98: 766-85.
37. McDonald HR, Schatz H. Grid photocoagulation for diffuse macular edema. Retina 1985; 5: 65-72.
38. Lee CM, Olk RJ. Modified grid laser photocoagulation for diffuse diabetic macular edema. Long-term visual results. Ophthalmology 1991; 98: 1594-602.
39. Jonas JB, Degenring RF, Kreissig I, Akkoyun I, Kamppeter BA. Intraocular pressure elevation after intravitreal triamcinolone acetonide injection. Ophthalmology 2005; 112: 593-8.
40. Al-Haddad CE, Jurdi FA, Bashshur ZF. Intravitreal triamcinolone acetonide for the management of diabetic papillopathy. Am J Ophthalmol 2004; 137: 1151-3.
41. Habib MS, Cannon PS, Steel DH. The combination of intravitreal triamcinolone and phacoemulsification surgery in patients with diabetic foveal edema and cataract. BMC Ophthalmol 2005; 5: 15.
42. Smithen LM, Ober MD, Maranan L, et al. Intravitreal triamcinolone acetonide and intraocular pressure. Am J Ophthalmol 2004; 138: 740-3.
43. Park HY, Yi K, Kim HK. Intraocular pressure elevation after intravitreal triamcinolone acetonide injection. Kor J Ophthalmol 2005; 19: 122-7.
44. Jaffe GJ, McCallum RM, Branchaud B, et al. Long-term follow-up results of a pilot trial of a fluocinolone acetonide implant to treat posterior uveitis. Ophthalmology 2005; 112: 1192-8.
45. Jonas JB, Degenring RF, Vossmerbaeumer U, et al. Frequency of cataract surgery after intravitreal injection of high-dosage triamcinolone acetonide. Eur J Ophthalmol 2005; 15: 462-4.
46. Westfall AC, Osborn A, Kuhl D, et al. Acute endophthalmitis incidence: intravitreal triamcinolone. Arch Ophthalmol 2005; 123: 1075-7.
47. Avci R, Kaderli B. Intravitreal triamcinolone injection for chronic diabetic macular edema with severe hard exudates. Graefes Arch Clin Exp Ophthalmol 2006; 244: 28-35.

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