European Journal of Ophthalmology / Vol. 11 no. 2, 2001 / pp. 145-149

A quantitative *in vivo* study of retinal thickness before and after laser treatment for macular edema due to retinal vein occlusion

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PURPOSE. *To evaluate quantitatively the effect of grid laser photocoagulation in macular edema due to central and branch retinal vein occlusion, using the retinal thickness analyzer.*
METHODS. *Five patients with cystoid and non-cystoid macular edema were studied before and after argon grid laser treatment. All were examined clinically, with fluorescein angiography, and measurement of retinal thickness. Macular thickness was correlated to visual acuity measured on the ETDRS chart.*
RESULTS. *Laser-slit images obtained with the retinal thickness analyzer in patients with macular edema disclosed discrete intraretinal changes after photocoagulation. Biomicroscopy and fluorescein angiography were insensitive to these small changes in the retinal thickness. No patient had any change in visual acuity after three months, but the retinal thickness was greater at this interval. The retinal thickening may be explained by a postoperative inflammatory response or by altered retinal blood flow or, in two of the eyes, by the effect of combined peripheral photocoagulation.*
CONCLUSIONS. *The retinal thickness analyzer offers a refined tool for the diagnosis of subclinical changes of macular edema in retinal vein occlusion and is therefore also useful for assessing the effects of treatment. (Eur J Ophthalmol 2001; 11: 145-9)*

KEY WORDS. *Macular edema, Retinal vein occlusion, Retinal thickness analyzer, Grid laser treatment*

Accepted: December 11, 2000

INTRODUCTION

After diabetes and age-related macular diseases, retinal vein occlusion (RVO) is the most common retinal disease. Typical fundus features include tortuosity and dilatation of the retinal veins; hemorrhages in the retina supplied by the occluded vein; swollen optic disk; cotton wool spots (1, 2). The most severe complications are cystoid macular edema, retinal ischemia and anterior segment neovascularization (rubeosis iridis and neovascular glaucoma) (3).

Current clinical methods for evaluating macular edema and retinal thickness are slitlamp biomicroscopy, stereophotography and fluorescein angiography, but it is extremely difficult to quantify the findings (4).

There are many possibilities for the treatment of macular edema; the efficacy of grid laser photocoagulation is confirmed in branch RVO, but is still debated in central RVO. It often leads to partial or complete resolution of the macular edema, but usually without visual improvement (5-8).

In the present study, we used the retinal thickness analyzer (RTA) in patients with macular edema due to RVO, before and after grid laser treatment, to check the changes in retinal thickness and see whether they were related to improvements in visual acuity.

 1120-6721/145-05$02.50/0

MATERIALS AND METHODS

Retinal thickness analysis

The RTA instrument (Talia Technology, Mevaseret Zion, Israel) consists of an optoelectronic unit and a computerized data acquisition and processing system. It is a non invasive, non contact, safe procedure, for fast measurement of retinal thickness anywhere in the posterior pole. A green HeNe laser beam, operating at a wavelength of 543 nm, mounted on a slitlamp biomicroscope, is expanded and directed into the eye by a scanning mirror and a fundus image lens. In 200 or 400 msec the laser scanner generates ten optical cross sections 200 µm apart, thus covering a 2x2 mm area on the fundus. The reflected images where the laser slit intersects the retina are recorded by a video camera and digitized. The separation between the two intersections from the vitreoretinal interface and from the retinal pigment epithelium is calculated with a customized software program (9, 10). The patient fixates on nine targets, to obtain nine scans which provide a quantitative thickness profile of the posterior pole. Each image is acquired at the video rate of 25 images per second.

For this study, we recorded and analyzed the thickness measured at the center of the fovea (mean foveal thickness) in the same way by the same examiner.

Subjects

Five patients aged from 50 to 78 years presenting with cystoid and noncystoid macular edema secondary to RVO (2 eyes with central RVO, 3 eyes with branch RVO were evaluated. Grid laser treatment was decided at six months after a documented visual decrease and stabilization of the macular edema observed biomicroscopically and by fluorescein angiography. Visual acuity ranged from 20/100 to 20/25. The patients had no retinal neovascularization, rubeosis iris, or angle neovascularization. All patients underwent grid laser photocoagulation applied in the area of macular edema, with a green argon laser, as usually described (5-8). Two patients with central RVO also had peripheral retinal ischemia and received combined panretinal photocoagulation.

Study design

Before and after grid laser treatment, a complete ocular examination was done, including best corrected visual acuity (with EDTRS charts for distance acuity, and Parinaud charts for reading), dilated fundus examination with contact lens, fluorescein angiography (which disclosed capillary leakage and the “petaloid” look in cases of cystoid macular edema, in the late angiogram at 5 minutes), and retinal thickness analysis. Changes in visual acuity and in retinal thickness at the center of the fovea were recorded.

RESULTS

Foveal thickening in one eye with central RVO progressed three months after grid laser treatment. In this eye the mean foveal thickness increased by 155 µm. In the other eyes no progression of the foveal

TABLE I - BASIC INFORMATION ON PATIENTS

Patients no.	RVO *	Pre-op VA †	Post-op VA ‡	Pre-op near VA §	Post-op near VA **	Treatment	Pre- and post-RTA (µ) ††
1	central	20/100	20/100	P6	P6	grid + PRP	325-434
2	central	20/100	20/100	P10	P10	grid + PRP	389-544
3	branch	20/25	20/25	P2	P2	grid	247-282
4	branch	20/70	20/70	P2	P2	grid	289-330
5	branch	20/70	20/70	P2	P2	grid	274-315

* Retinal vein occlusion; † pre-operative distance visual acuity (EDTRS); ‡ post-operative distance visual acuity (EDTRS); § pre-operative near visual acuity (Parinaud test); ** post-operative near visual acuity (Parinaud test); †† pre- and post- operative retinal thickness analyzer measurement; PRP: panretinal photocoagulation

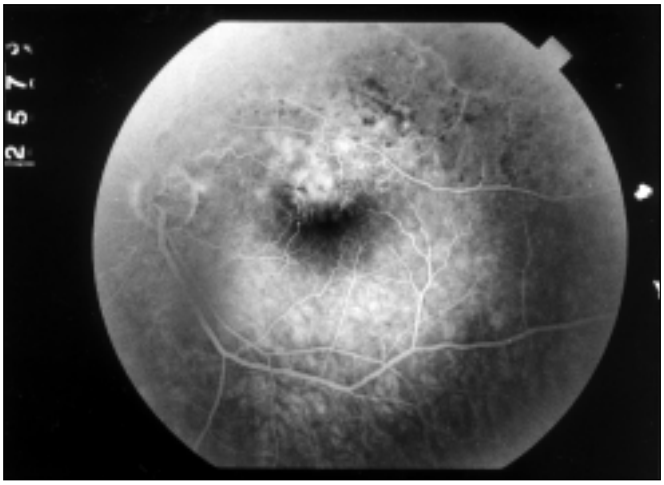

Fig. 1 - *Patient 3. Late phase fluorescein angiogram, before grid laser treatment shows hemorrhage and intraretinal leakage of fluorescein (macular edema).*

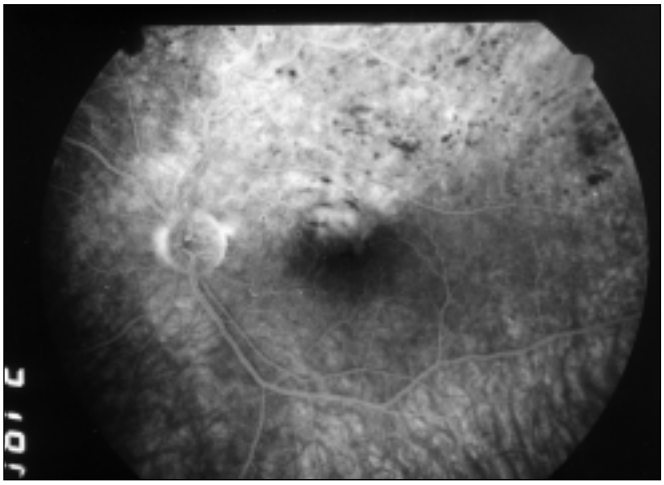

Fig. 2 - *Patient 3. Late phase fluorescein angiography, three months after grid laser treatment shows laser spots at the treated site and persistent macular edema.*

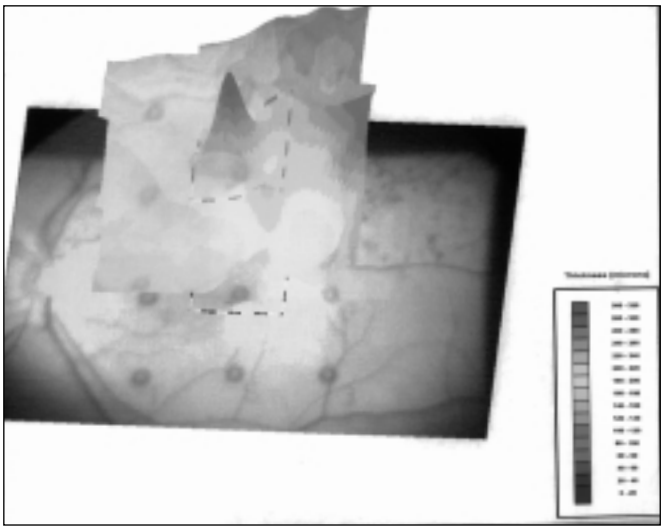

Fig. 3 - *Patient 3. Three-dimensional mesh obtained from RTA shows the increase in mean foveal thickness (247 µm) due to branch retinal vein occlusion.*

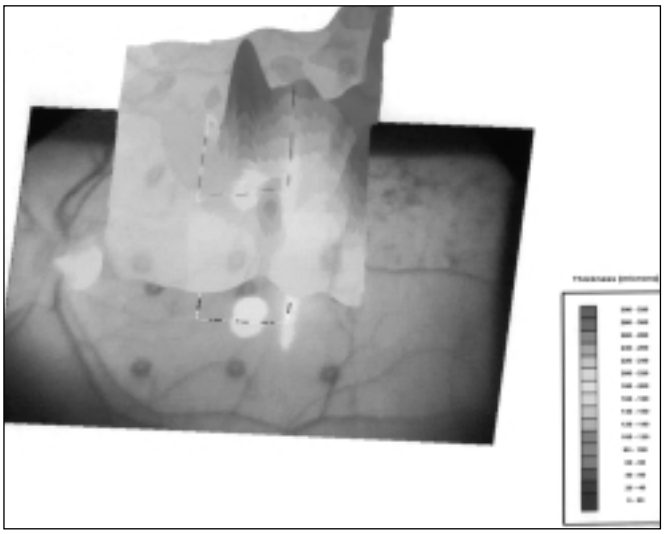

Fig. 4 - *Patient 3. Three-dimensional mesh obtained from RTA shows the mean foveal thickness (282 µm) three months after grid laser treatment.*

thickening was suspected biomicroscopically.

Fluorescein angiography examination three months after treatment showed no change in the appearance of the cystoid or non-cystoid macular edema, except in the case mentioned. In one eye with the central RVO and 155 µm increase in mean foveal thickness the late phase of the fluorescein angiogram disclosed the typical petaloid cystoid in the macular area.

Before laser treatment, the best corrected visual acuity in the two eyes with central RVO was 20/100, and the mean foveal retinal thickness was 325 µm in one eye and 389 µm in the other (Tab. I). Three months after grid laser treatment, visual acuity remained unchanged but the mean foveal thickness increased by 18 µm in one eye and by 155 µm in the other. These two patients had also been treated by panretinal photocoagulation. In the three eyes with branch RVO, the best corrected visual acuity did not change three months

after laser treatment. The mean foveal thickness increased by 41 µm. The eye with the best initial acuity (20/25), with a mean foveal thickness of 247 µm, had stable acuity after laser treatment and foveal thickness had risen to 282 µm (Figs. 1-4).

DISCUSSION

Although fluorescein angiography is the method used clinically for detecting the fluid leakage that causes macular edema, the relation between retinal thickening from fluid accumulation and fluorescein dye leakage into the extravascular retinal space has not been established. The scanning RTA offers a new way of measuring retinal thickness in the macular area. Depth resolution and precision of the scanning RTA are reported to be 50 and 10 µm, respectively (10).

Subclinical macular edema occurs six weeks after scatter photocoagulation in diabetic patients, but with no visual loss. The RTA may be a sensitive instrument for early detection of diabetic macular edema after laser treatment (11).

The ability of the RTA to document foveal thickening in retinitis pigmentosa patients with cystoid macular edema was evident after carbonic anhydrase treatment. This method is useful for evaluating the response to this therapy when thickening becomes normal in eyes that had moderate thickening (12). Thus, this method might be useful to select eyes that might benefit from this therapy. The RTA provides a rapid and precise evaluation of macular thickening in patients with RVO and the reproducibility of these measurements has been confirmed (13).

We investigated the change in retinal thickness after grid laser treatment for macular edema in RVO and its possible relation to visual acuity, in order to define prospectively the effect of photocoagulation on foveal retinal thickness. Foveal thickness increased in all RVO patients, but visual acuity remained unchanged.

Comparison of retinal thickness and visual acuity indicated that foveal thickness may increase even in the absence of concomitant visual loss. The increase may be due to a postoperative inflammatory response or to further alteration of the already impaired retinal blood flow or, in two eyes, by the effect of combined peripheral photocoagulation.

In conclusion, the RTA can assess changes in macular retinal thickness in patients with macular edema due to central and branch RVO after grid laser photocoagulation, that cannot be detectable with the biomicroscope or by angiography. Therefore, this apparatus provides information on the exact retinal thickness that cannot be obtained using current clinical and angiographic examinations, and that might help us understand the causes of changes in visual function or the mechanisms of action of therapy. RTA seems useful for the diagnosis and the prognosis of macular edema due to RVO, as well as for following its course and assessing the response to the treatment.

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