Evaluation of Functional Defects in Branch Retinal Vein Occlusion before and after Laser Treatment with Scanning Laser Perimetry

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Objective: This study was aimed at localizing and quantifying retinal defects in patients with branch retinal vein occlusion by means of scanning laser perimetry and analyzing the mechanism involved in the functional recovery after laser therapy.

Design: Prospective nonrandomized clinical trial with concurrent comparison group.

Participants: Fifty-eight patients with isolated branch retinal vein occlusion. Thirty-nine eyes received laser treatment; 19 eyes were observed without treatment.

Intervention: Argon laser photocoagulation was performed according to the Branch Vein Occlusion Study recommendations.

Main Outcome Measures: Retinal functional deficits were evaluated with scanning laser perimetry and fluorescein angiography first at baseline, at 3-month follow-up visits and 3 months after laser treatment.

Results: After laser treatment, the scotoma encroached on foveal fixation in 31% of eyes, remained stable in 36%, and regressed from the foveal avascular zone in 33%. Improvement in vision was correlated with increasing scotoma distance from fixation. Total scotoma size increased in 50% of eyes after treatment. Depth of scotoma and degree of angiographic leakage showed no direct correlation.

Conclusions: Stabilization and increase in visual acuity after laser treatment did not correlate with an overall decrease in scotoma size. Improved central visual function seen in 25% of treated eyes appeared to be due to withdrawal of scotoma from the fovea. Ophthalmology 2000;107:1089–1098 © 2000 by the American Academy of Ophthalmology.

Branch retinal vein occlusion (BRVO) is a common retinal disease causing visual loss and is associated with various risk factors including systemic hypertension, high body mass index, and diabetes mellitus. The impact of venous thrombosis on retinal function varies considerably and depends largely on the site of vessel obstruction (hemifield, major, and macular BRVO), and the completeness of occlusion ranging from ischemic to nonischemic types.

Central visual acuity measurements offer only limited information about the intensity and localization of the retinal damage that follows occlusion with variable perfusion areas. Angiography is limited to imaging anatomic changes, whereas electrophysiology only reflects changes caused by any inner retinal defects and fails to provide topographic localization. The intensity and size of scotomas and their relation to the fovea are not adequately documented.

Furthermore, quantification of the therapeutic effects of laser is often imprecise. The Branch Vein Occlusion (BVO) Study showed that macular grid laser treatment improved visual acuity in selected groups of patients; in those in whom BRVO persisted for more than 3 months, visual acuity was less than 20/40 and edema was affecting the fovea.

In contrast to the observed improvement in central visual acuity after laser intervention, visual field defects after peripheral laser treatment with sectorial ablation have also been documented.

Our aim was to quantify and localize functional deficits after BRVO and to study the effect of laser therapy on central retinal sensitivity. Scanning laser ophthalmoscopy allows a topographic mapping of retinal function. Affected areas may be tested under real-time visualization and fixation control. SLO perimetry was used in patients with BRVO to quantify the intensity, depth, and dimension of central and paracentral scotomas. Functional findings were correlated with angiographic features to evaluate the impact of nonperfusion or leakage on retinal sensitivity. The functional retinal status was documented before and after laser...
therapy to evaluate the impact of treatment on the outcome of BRVO.

Materials and Methods

Patients with isolated newly diagnosed macular BRVO within the vascular arcades were enrolled in a prospective, nonrandomized study. The study population was recruited from a consecutive series of patients referred to a tertiary specialty clinic. Patients with additional diseases that might compromise visual acuity such as diabetic retinopathy or glaucoma were excluded.

Systemic hypertension was diagnosed if antihypertensive medication was taken regularly or when blood pressure was >150/100 mmHg on repeated measurements.

All patients underwent a comprehensive examination, including best-corrected distance visual acuity measured using the Early Treatment Diabetic Retinopathy Study (ETDRS) chart and dilated funduscopy. Stereo fundus photography and fluorescein angiography were performed at the first (baseline) examination and 3 months after each laser treatment.

Angiographies were analyzed on the basis of diapositive projection and graded by two independent readers for the presence of avascular areas, exudative changes only, or mixed areas with ischemia and exudation. In addition, the foveal capillary ring was evaluated as intact or broken.

Microperimetry was performed within 2 to 7 days of angiography at each follow-up visit. Retinal sensitivity was examined using a Rodenstock Scanning Laser Ophthalmoscope Munich, Germany 101 ("scotometry" version 1:1). A standardized grading system of stimuli ranging in 0.1 log-steps from 0 to 32 dB was used. Stimulus intensities were varied in steps of decibels, with a baseline value of 0 dB representing the most intensive stimulus and stepwise reduction in stimulus brightness indicated by an increase in decibel values. The retinal threshold was measured in three different areas: zones of nonperfusion, the adjacent edematous zone, and adjacent areas with intact perfusion. Absolute and relative scotomas and the localization of fixation were studied with 150 to 200 stimuli per examination. Scotoma size and its relationship to the center of the fovea were evaluated at each examination and compared with follow-up results.

The test protocol required evaluation of the area with best maintenance of function first, defining the lowest stimulus intensity recognized (positive scotoma), followed by determination of the deepest defect with the highest intensity level not recognized (negative scotoma) within the area of BRVO. Each examination was initiated by defining the threshold for the least intense stimulus corresponding to the maximal sensitivity overlaying intact central retina by offering stimuli with decreasing intensity. Subsequently, the area demonstrating the most pronounced vascular occlusion angiographically was tested with a series of stimuli with increasing intensity to capture the threshold for the deepest defect. If nonperfusion were not present angiographically, the area with the most intense exudation was evaluated. The borders of both maximum function and maximum defect areas were precisely defined and any lateral extensions were monitored by use of a dense pattern of stimuli. The area located between intact retina (best function) and retina affected by vascular occlusion (deepest defect) typically represented the collateral edematous zone clinically and angiographically. This area was then tested by defining the highest stimulus intensity that was not recognized homogeneously over 90% of the entire area. The characteristic distribution of the tested areas and intensity thresholds are presented in Figure 1.

Fifty-eight consecutive patients were enrolled in the study. Laser treatment was offered based on BVO Study Group criteria: persistence of BRVO for more than 3 months, visual acuity less than 20/40, and edema affecting the fovea. Thirty-nine patients met these criteria and all received laser treatment. Nineteen eyes did not meet these criteria and were observed as a nonrandomized control group. No patient refused laser treatment, when indicated. Treatment decisions were always made prospectively.

Laser treatment was performed using a grid of argon laser photocoagulation applied to areas of edema seen clinically and to the leakage seen on fluorescein angiography but no closer than 300 μm from the center of the foveal avascular zone. The spot size used was 100 to 200 μm with 0.1-sec duration using a quadruphonic or goldmann lens. The burns were spaced one burn width apart and were distributed in a gridlike pattern with light to medium white intensity. Scotometry was again performed 3 months after laser therapy with stimuli of identical intensity.

For statistical analysis, continuous variables were summarized using standard deviations of the mean (SEM) and medians. Categorical variables were summarized using frequency and percentage. Correlation between baseline and follow-up visual acuity was examined by use of the Wilcoxon rank-sum test. Correlation between baseline clinical measures (e.g., retinal sensitivity and other categorical measures) was examined using nonparametric tests (e.g., Spearman rank coefficient). Statistical significance was accepted at α set at 0.05.

Results

Fifty-eight eyes of 58 consecutive patients with BRVO were enrolled in the study. There were 26 men and 32 women, ages 33 to 84 years. The baseline visual acuity in the study eyes ranged from 20/400 to 20/20, with a mean visual acuity of 20/50. At initial presentation with BRVO, the retinal sensitivity in the area of occlusion on average diminished to 10 dB (± 4.8 dB). In the collateral edematous zone, retinal threshold was reduced to 22 dB (± 3.05 dB). Figure 1 illustrates a characteristic scotometry mapping (Fig 1A) at initial presentation with BRVO correlated with fluorescein angiography (FA) (Fig 1B). The difference in retinal threshold between the area of occlusion and the area of intact perfusion was statistically significant (P < 0.01; Spearman rank correlation). Table 1 summarizes the results of scotometry in decibels.

Within the occluded areas, defects of significantly differing intensity were found that only partially correlated with the angiographic appearance. Because of the interindividual variability of functional defects within the area of occlusion, this group was further analyzed, and subgroups were defined as shown in detail in Table 1. The classification into different categories was based on the degree of functional loss measured by microperimetry. Three subgroups were defined:

Group 1 demonstrated an absolute scotoma with no stimulus recognized even at the highest stimulus intensity (0 dB).

Group 2 included patients with no statistically significant difference in sensitivity detected within the affected area compared with the optimal mean sensitivity of intact retina and its variation in the study group at 26 dB ± 1.4 dB.

Group 3 showed relative defects scattered between 4 and 24 dB without forming clusters.

Statistical analysis indicated that the difference between the retinal threshold within the area of occlusion and the area of intact perfusion was significant with $P < 0.01$ using the Spearman rank correlation. The difference between retinal thresholds of edematous zones and areas with intact perfusion was not statistically
significant. Figures 2 A–C indicate the distribution of the individual data points for retinal sensitivity. Absolute scotomas (0 dB) were observed in 34.7% of the eyes examined. Angiographically nonperfused areas or extensive intraretinal hemorrhage were often, but not always, present in these cases. Relative scotomas (average 13.5 dB) were seen in 53.1% and mostly correlated with small avascular areas or capillary dropout by early FA and marked exudation during late FA phases. Minimal, nonsignificant defects (average 25.8 dB) were documented in 12.2% of eyes in the area of presumed thrombosis. There were no signs of vascular occlusion angiographically, and these scotoma zones frequently corresponded to areas showing only leakage by angiography.

The level of angiographically documented leakage did not always directly correlate with functional deficits documented by micropereimetry. Conventional angiography used in this study did not allow a quantification of leakage. Hence, a quantitative correlation of sensitivity loss and grade of leakage could not be performed. However, a wide range of exudation seen by angiography was associated with similar levels of discrete functional loss. In particular, extensive leakage was not found to correlate with significant reduction in retinal sensitivity (Fig 3A, B).

Thirty-nine of 58 patients with BRVO underwent laser therapy according to the recommendations of the BVO group. In 17 of these eyes a second treatment was performed 3 months later on the basis of persistent angiographic leakage. Five patients required a third treatment after an additional 3-month period.

The visual acuity of the entire group of patients at initial presentation was on average 20/50. Untreated eyes improved to a mean of 20/32 after 3 months. In the treatment group, visual acuity remained stable at 20/50 after the first treatment course. Eyes with completely resolved exudation were not retreated and remained at
20/50 in the long-term follow-up. Eyes with persistent leakage were retreated for a second or third time. This group finally increased in visual acuity to 20/40. Visual acuity results are presented in Table 2A.

The relationship of scotomas to the foveal avascular zone (FAZ) was evaluated in the treatment group before and after photocoagulation (Table 2B). At the final examination, the scotoma borders were found closer to the fovea in 31% of treated eyes, remained unchanged in 36%, and the central border of the defect withdrew from the FAZ in 33%. The dimensions of the absolute and relative scotomas were measured from the central outline of the defect in direction of the temporal vascular arcade as a peripheral border. These measurements were made to capture changes in the size of the central scotomas; peripheral alterations extending beyond the temporal vascular arcades were excluded (Table 2C). Changes in scotoma size were analyzed separately from their relation to the fovea. In 20% of eyes functional defects increased after the first treatment. In addition, 7 of 17 eyes showed progressive defects after the second treatment. After therapy, 10 of 39 eyes had smaller scotomas. In most cases, the scotoma extended peripherally toward the vascular arcades. In some of these eyes, progressive vascular occlusion was noted angiographically. Increased scotoma sizes did not correlate with distance of the defect to the FAZ.

Figures 4–6 illustrate characteristic perimetric findings of central visual fields before and after laser treatment. Functional recovery occurred in untreated areas adjacent to the immediate BRVO, when leakage originating from the affected area was reduced subsequent to laser therapy (Fig 4). Mild relative scotomas extending through the opposite portion of the macula were often found in BRVO of the superior temporal branch, most likely a result of fluid permeating into lower parts of the retina because there was no substantial active leakage seen by angiography in the inferior macula in these cases, excluding BRVO of the inferior branch. Recovery of the corresponding portion of the macula after resolution of leakage after laser therapy was a frequent finding in these cases.

Retinal sensitivity also improved within BRVO areas directly treated with laser (Fig 5), which had impaired perfusion at baseline.

After laser therapy, the scotomas increased in 50% of eyes, mostly in temporal direction (Fig 6).

Mean retinal threshold as documented in areas with angiographic occlusion, exudation only, or intact central perfusion. BRVO was responsible for intense defects in 87.8%. In a subset of eyes (12.2%) nonperfusion was primarily absent at baseline angiography, corresponding to mild defects not significantly different from zones with exudation only or with intact perfusion. The difference between retinal sensitivity in areas with retinal vascular occlusion and sensitivity within areas with intact perfusion was statistically significant (P < 0.01). There was no statistical significance between the threshold in edematous zones compared with areas with intact perfusion.

<table>
<thead>
<tr>
<th>Angiographic Appearance</th>
<th>Mean Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular occlusion</td>
<td>10 dB (±4.8 dB)</td>
</tr>
<tr>
<td>Absolute scotoma (0 dB): 34.7%</td>
<td></td>
</tr>
<tr>
<td>Relative scotoma (average 13.5 dB): 53.1%</td>
<td></td>
</tr>
<tr>
<td>Nonsignificant defects (average 25.8 dB): 12.2%</td>
<td></td>
</tr>
<tr>
<td>Edematous zone</td>
<td>22 dB (±3.05 dB)</td>
</tr>
<tr>
<td>Intact perfusion, no edema</td>
<td>26 dB (±1.4 dB)</td>
</tr>
</tbody>
</table>

Visual acuity was analyzed before and after treatment. With respect to the distance of the scotoma borders to the FAZ, a better visual outcome was positively correlated with a greater distance between scotoma and FAZ (P = 0.05; Fig 7). The patient group in which scotoma distance from the FAZ decreased showed a trend toward visual acuity reduction without reaching statistical significance.

Ninety percent of patients in the group with diminished retinal function and failure to recover had systemic hypertension. Among
patients who demonstrated improved retinal function and resolution of foveal edema, only one had a history of hypertension. A broken capillary ring was observed in 80% of eyes at baseline; this condition had no influence on the prognosis of retinal sensitivity in the study.

**Discussion**

BRVO may lead to a significant reduction of central and paracentral retinal function. In addition to measuring visual acuity, SLO provides precise information about localization and intensity of retinal damage.

At baseline, retinal function was evaluated in three different areas: areas of vascular occlusion, the collateral edematous zone, and adjacent areas of intact perfusion.

Retinal function was significantly reduced in areas of vascular occlusion compared with areas showing leakage but intact perfusion. Within the occluded area itself, we found defects with a wide range of intensities. About one third of the patients initially had absolute scotomas, which correlated on angiography to avascular areas at the maximum stimulus of 0 dB.

Angiographically observed leakage, contrary to expectations, did not directly correlate with the magnitude of retinal sensitivity loss. Often, eyes with substantial exudation showed only discrete functional loss.

The stabilization and increase of visual acuity after laser treatment did not correlate with an overall decrease in the scotoma size after therapy. Rather, the withdrawal of scotoma from the fovea seemed to be responsible for the improved central visual function seen in 25% of treated eyes.

We observed an increase in posttreatment scotoma size in more than 50% of the patients. The scotomas usually expanded peripherally in the direction of the vascular arcades. It cannot be conclusively established whether this enlargement is due to ganglion fiber damage caused by laser therapy or whether it is the result of additional occlusive

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**Figure 3.** A, Angiography reveals substantial exudation covering the area of BRVO correlating to the intraretinal edema seen clinically. B, A small circumscribed scotoma with only minor reduction in retinal sensitivity is detected by microperimetry.
Figure 4. Microperimetry before and after laser therapy with improvement within an area adjacent to the treated region. At baseline a large defect extends through the affected area of the BRVO (superior to the fovea) and the adjacent intact macular portion inferior to the fovea (A). After laser therapy, the exudation has cleared from the treated area angiographically and clinically, and there has been improvement in retinal sensitivity within the adjacent macular area not directly exposed to laser coagulation (B).

Figure 5. Microperimetry before and after laser treatment with improvement of retinal function within the laser-treated area. A large scotoma covering the lower portion of the macula was documented before treatment (A). Scotoma depth was 24 dB within the area of occlusion and 28 dB within the collateral edematous zone indicated by the full symbols and red numbers encoding stimuli not recognized by the patient. Three months after laser, the site of previous scotoma has recovered substantially within the occluded area and the adjacent edematous zone, indicated by open symbols and green numbers for recognized stimuli. Although laser coagulation was applied directly to the ischemic area, retinal sensitivity has improved homogeneously.
Figure 6. Although the scotoma is limited in size before laser therapy (A), the defect area has enlarged temporally and toward the mid periphery 3 months after therapy (B).
The purpose of the study was to evaluate the immediate
selection of the recruited population referred to the hospital.
A small number of patients in our study group, a different
two or more lines. This difference might be explained by the
results in treated patients before and after laser therapy
improvement was higher in the BVO study,
was often no evidence of persistent occlusion angiographi-
cally and/or the area of exudation was small and located
outside the fovea. This group was therefore not considered
to be a valuable control group for retinal recovery. Indeed,
in 5 of 19 patients who were followed for 3 months and
again underwent microperimetry testing, scotoma size and
intensity were substantially reduced in all cases.

The Branch Vein Occlusion Study Group, a randomized
trolled multicenter clinical study, showed that laser ther-
ry is beneficial to the preservation of visual function4,5,9 in
selected well-defined cases. Therefore, this study, representing
a pilot study, was limited to observations in patients who
did not meet the treatment criteria and to the comparison of
results in treated patients before and after laser therapy
without designing an untreated control group. However, the
BVO study also showed that there was no difference in
outcome whether the patient was treated at 6 or 18 months.
Hence, a randomized control group may be included in
future trials with laser treatment withheld for up to 18
months.

Visual acuity results with a final visual outcome of 20/40
were similar to the findings of the BVO study group. How-
ever, overall improvement was higher in the BVO study,
which showed that at 3 years 65% of patients had gained
two or more lines. This difference might be explained by the
small number of patients in our study group, a different
selection of the recruited population referred to the hospital
and, more importantly, a much shorter follow-up interval.
The purpose of the study was to evaluate the immediate
impact of photocoagulation on retinal sensitivity of the
treated area and its close vicinity. Foveal function might
further improve during long-term follow-up as seen by the BVO
group after 3 years.

In addition, microperimetry documented the strong in-
fluence of the nature of the disease, with its progression
showing an unpredictable enlargement of scotoma, presum-
ably unrelated to the treatment, overriding the localized
effects of laser therapy. Continuing extension of ischemia-
induced functional loss is most likely due to progressive
malperfusion. Donati et al10 reported that development of
extended areas of nonperfused capillaries correlated with
the secondary constriction of arterioles after experimental
BRVO in animals.

A progressive stagnation of capillary flow and continued
formation of focal thrombi11 may cause progressive and
irreversible photoreceptor impairment, which cannot be in-
fluenced by laser intervention. Nonischemic central retinal
vein occlusion (CRVO) progresses in 15% of cases to ischemic CRVO within 4 months12; this is a prognosis that
might also apply to BRVO. Even drastic therapeutic inter-
ventions such as chorioretinal venous anastomosis13,14 do
not prevent progression of CRVO experimentally. Histopa-
thropathologically, photocoagulation can potentially worsen
the condition of the ischemic areas by inducing further
capillary atrophy, as observed by Wilson et al.15

In this study, we documented precisely the impact of
exudation on retinal function. Extensive exudation observed
angiographically at baseline caused only a discrete reduc-
tion in retinal sensitivity. Sperduto et al1 and Finkelstein4
have discussed the mechanisms of edema in detail, distin-
guishing vasogenic from cytotoxic edema. Isolated vaso-
genous edema may be responsible for the relatively good
maintenance of photoreceptor function in some eyes.

It may also account for the improvement of retinal sen-
sitivity through resolution of exudation after laser treatment.
Resolution of edema normalizes diffusion in the tissue and
improves the supply of oxygen and metabolites.17 It seems
likely that edema alone is not the cause of significant
decreased retinal function. Intravascular swelling of edem-
atosous tissue could produce an increased capillary obstruc-
tion and induce a “circulus vitiosus” of edema and ischemia
by means of capillary closure caused by high tissue pres-
sure.13

Capillary dropout is a discrete feature and is not easily
documented by conventional camera-guided angiography.
The influence of an alteration of the perifoveal capillary
arcade on the prognosis of BRVO remains a controversial
issue. Some authors postulate a correlation between unfa-
vorable prognosis and a broken capillary ring,16 while oth-
ers relate a positive outcome with alterations of the perifo-
veal net.7 New imaging methods such as laser scanning
techniques provide improved documentation of microvas-
cular damage. Remky et al17 demonstrated an almost uni-
form enlargement of perifoveal intercapillary areas in pa-
ients with CRVO. A functional test such as microperimetry
might allow a more reliable evaluation of capillary-based
ischemia by measuring ischemia-induced photoreceptor
damage. Overlying edema often masks capillary avascu-
larlity. Microperimetry appears to offer excellent guidance for

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### Table 2A. Summary of Visual Acuity at Baseline and after Therapy

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Visual Acuity (Median)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (n = 58)</td>
<td>20/50</td>
</tr>
<tr>
<td>No treatment follow-up (n = 19)</td>
<td>20/32</td>
</tr>
<tr>
<td>After laser treatment 1 (n = 39)</td>
<td>20/50</td>
</tr>
<tr>
<td>After laser treatment 2 (n = 17)</td>
<td>20/40</td>
</tr>
<tr>
<td>After laser treatment 3 (n = 5)</td>
<td>20/40</td>
</tr>
</tbody>
</table>

### Table 2B. Changes in the Distance of the Scotoma from Foveal Avascular Zone

<table>
<thead>
<tr>
<th>Fovea/Scotoma after Laser Treatment</th>
<th>No. Eyes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closer to the fovea</td>
<td>12</td>
</tr>
<tr>
<td>Unchanged</td>
<td>14</td>
</tr>
<tr>
<td>More distant from the fovea</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
</tr>
</tbody>
</table>

### Table 2C. Changes in Scotoma Size before and after Treatment

<table>
<thead>
<tr>
<th>Scotoma Size</th>
<th>After First Treatment</th>
<th>After Second Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unchanged</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Larger</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Smaller</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>17</td>
</tr>
</tbody>
</table>
laser treatment and other modalities. If retinal sensitivity is extremely poor, the affected areas are ischemic and will not benefit from treatment. This was seen in a third of eyes with deep scotoma and 0 dB threshold. On the other hand, intense leakage noted by angiography but presenting no functional defects should not be coagulated because of the risk of damaging relatively intact areas.

The rate of improvement of foveal function by photocoagulation was approximately 25%. Benefits may thereby occur within adjacent edematous areas and in the coagulated area itself. Improvement of central visual acuity might develop even in the presence of an enlargement of paracentral scotomas. Furthermore, the potential for recovery in BRVO is higher in the absence of systemic hypertension. The presence of hypertension may correlate with poor functional recovery because most patients with progressive or unchanged sensitivity loss had systemic hypertension. Hypertension may not be the only condition of the pathogenesis of the underlying disease but also substantially affect progression or the ability to recover independent of any laser intervention.

Acknowledgments. The authors thank Jennifer Arnold, MD, Royal Infirmary Aberdeen, Aberdeen, Great Britain; Eric Friedmann, Triton, NY; and Frans van de Velde, PhD, Schepens Eye Institute, Boston, for their helpful discussion.

References


Drs. Barbazetto and Schmidt-Erfurth documented the change of scotoma size before and after laser treatment in branch retinal vein occlusion (BRVO). Their selection criteria for laser treatment followed the recommendations of the BRVO study group. Inclusion criteria were the presence of macular edema for more than 3 months, a visual acuity equal to 20/40 or worse, and the existence of an intact foveal capillary zone without hemorrhages. Of the 53 eyes that were included in their study at the beginning, 36 eyes underwent one or more treatment sessions. Twenty-five percent of these patients showed an improvement over time. The authors evaluated not only scotoma size but also the direction of change of the scotoma boundaries (i.e., whether the scotoma expanded toward the foveal area or at the distal side away from the fixation area).

Two observations can be made. First, it is difficult to outline the size and depth of the scotoma of a BRVO, even with scanning laser ophthalmoscopy (SLO), because scotomas of retinal origin are usually complex in shape and intensity profile, especially after laser treatment. In addition, a nonthresholding technique has been used. It is therefore difficult to plot isopters corresponding to a particular stimulus intensity or to determine the retinal sensitivity of a regular grid of stimulus locations in static perimetry, especially in the presence of unsteady fixation. Recent advances in algorithmic design should allow a precise thresholding of selected retinal locations under rigorous control of fixation. The data presented in this study suggest the measurement of foveal thresholds. Changes in foveal retinal sensitivity will correlate with the author’s distance of the scotoma border to the fovea.

A second observation concerns the determination of visual acuity before and after laser treatment. In their study, the authors used the EDTRS chart. Differences between 20/40, 20/50, and 20/70 are considered statistically significant. Often, patients learn to see acuity targets with a slightly different retinal area than the usual preferential locus of fixation (PRL). It has been documented with SLO that the acuity can be reduced in the fovea to 20/100 yet the patient manages to “read” the 20/63 line with an extrafoveal area. SLO offers the advantage of measuring acuities while observing the location that is used for recognition of the acuity target, and this allows us to see whether this area is different from the usual PRL.

In conclusion, the article demonstrates that SLO microperimetry can be an objective “gold standard” for the evaluation of treatment protocols of macular diseases.