Radial Optic Neurotomy for Management of Hemicentral Retinal Vein Occlusion

Jose Garcia-Arumi, MD; Anna Boixadera, MD; Vicente Martinez-Castillo, MD; Hugo Blasco, MD; Alejandro Lavaque, MD; Borja Corcostegui, MD

Objective: To evaluate the effect of radial optic neurotomy on visual acuity (VA) and foveal thickness in patients with hemicentral retinal vein occlusion.

Methods: A prospective noncomparative case series of 13 eyes in 13 patients with hemicentral retinal vein occlusion and a preoperative VA of 20/60 or less from a total of 232 retinal vein occlusions diagnosed. All patients underwent pars plana vitrectomy, posterior hyaloid dissection, and radial optic neurotomy at the nasal border of the optic disc.

Results: Visual acuity and macular thickness were measured with optical coherence tomography. Nine patients (69.2%) gained 2 or more Snellen lines of vision, and in 4 patients (30.8%) VA improved by 4 or more Snellen lines (median visual acuity, 20/50; mean VA, 20/45; P<.01) (average gain, 2.7 Snellen lines). The decrease in foveal thickness was statistically significant (P<.01) (median decrease, 297 µm). Final VA was statistically related to decreased macular thickness at optical coherence tomography (P=.03; p = −0.62). Retinochoroidal shunts developed in 6 patients (46.1%) at the radial optic neurotomy site. No surgical complications were observed.

Conclusions: Radial optic neurotomy seems to be a potential treatment in selected patients with hemicentral retinal vein occlusion, probably because of the more rapid appearance of retinochorioretinal collateral vessels, which promote faster resolution of macular edema.

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of a total of 232 retinal vein occlusions (92 CRVOs, 105 branch retinal vein occlusions, 20 HCRVOs, and 15 hemispheric retinal vein occlusions).

One of the inclusion criteria was a VA of 20/60 or worse owing to macular edema secondary to HCRVO within 3 months of onset. The 7 patients with HCRVO and a visual acuity better than 20/60 were observed but excluded from the study. Exclusion criteria were previous laser photocoagulation and vitreous hemorrhage or retinal neovascularization secondary to HCRVO. Patients were fully informed of all aspects of the procedure and all provided written informed consent. Ethics committee approval was obtained for this study.

Preoperative recorded data included patient age, sex, and race; affected eye; bilaterality; time from onset of HCRVO; refraction; and measurement of VA using the Early Treatment Diabetic Retinopathy Study chart. Also recorded were risk factors, such as hypertension, open-angle glaucoma, hyperlipidemia, primary antiphospholipid antibody syndrome, and other thrombophilic factors.

All 13 eyes underwent indirect ophthalmoscopy and slit-lamp examination, including biomicroscopy of the vitreous and retina. Fundus photography and fluorescein angiography were also performed in each patient. The type of CRVO was not classified as perfused or nonperfused, as in the Central Vein Occlusion Study, because a substantial number of patients had no systemic disease. In 1 patient (patient 6) APS, antiphospholipid antibody syndrome in 1 (7.7%). Only 2 patients had a branch retinal vein occlusion, 20 HCRVOs, and 15 hemispheric retinal vein occlusions.

The 13 patients (8 men and 5 women) ranged in age from 41 to 80 years (median age, 69 years). Follow-up ranged from 6 to 12 months postoperatively (mean, 8 months). Preoperative BCVA ranged from 20/400 to 20/60 (median, 20/100). Preoperative foveal thickness measured by OCT varied from 364 to 971 µm (median, 558 µm).

Each patient had a symptomatic decrease in VA in the affected eye due to HCRVO of less than 12 weeks’ duration (range, 2-11 weeks; median, 6 weeks from onset). Of the 13 patients, systemic hypertension was present in 9 (69.2%), primary open-angle glaucoma in 4 (30.8%), diabetes mellitus in 6 (30.8%), and antiphospholipid antibody syndrome in 1 (7.7%). Only 2 patients had no systemic disease. In 1 patient (patient 6) was in the fellow eye caused neovascular glaucoma, and 5 patients (patients 2, 4, 5, 11, and 12) (38.5%) had a branch retinal vein occlusion.

Patient demographic data are given in the Table. Hemicentral retinal vein occlusion was superior in 6 patients and inferior in 7 patients.

### Table. Patient Demographic Data

<table>
<thead>
<tr>
<th>Case No./Sex/Age, y</th>
<th>Eye</th>
<th>Systemic Pathologic Conditions</th>
<th>Time From Onset of HCRVO, d</th>
<th>VA Initial/Final</th>
<th>OCT, µm Preoperative/Final</th>
<th>Collateral Vessels</th>
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<tbody>
<tr>
<td>1/M/54</td>
<td>OD</td>
<td>HBP and HL</td>
<td>28</td>
<td>20/200/20/25</td>
<td>653/231</td>
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<td>OD</td>
<td>HBP and DM</td>
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<td>20/60/20/40</td>
<td>811/179</td>
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<tr>
<td>3/M/80</td>
<td>OD</td>
<td>NRF</td>
<td>60</td>
<td>20/200/20/80</td>
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<tr>
<td>4/F/69</td>
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<td>HBP</td>
<td>37</td>
<td>20/60/20/50</td>
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<td>HBP and DM</td>
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<td>20/200/20/100</td>
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<td>Yes</td>
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<tr>
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<td>APS</td>
<td>40</td>
<td>20/200/20/30</td>
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<td>DM</td>
<td>50</td>
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<td>60</td>
<td>20/400/20/90</td>
<td>680/202</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Abbreviations: APS, antiphospholipid antibody syndrome; DM, diabetes mellitus; HCRVO, hemicentral retinal vein occlusion; HBP, high blood pressure; HL, hyperlipidemia; NRF, no risk factor; OCT, optical coherence tomography; VA, visual acuity.

The 13 patients (8 men and 5 women) ranged in age from 41 to 80 years (median age, 69 years). Follow-up ranged from 6 to 12 months postoperatively (mean, 8 months). Preoperative BCVA ranged from 20/400 to 20/60 (median, 20/100). Preoperative foveal thickness measured by OCT varied from 364 to 971 µm (median, 558 µm).

Each patient had a symptomatic decrease in VA in the affected eye due to HCRVO of less than 12 weeks’ duration (range, 2-11 weeks; median, 6 weeks from onset). Of the 13 patients, systemic hypertension was present in 9 (69.2%), primary open-angle glaucoma in 4 (30.8%), diabetes mellitus in 6 (30.8%), and antiphospholipid antibody syndrome in 1 (7.7%). Only 2 patients had no systemic disease. In 1 patient (patient 6) was in the fellow eye caused neovascular glaucoma, and 5 patients (patients 2, 4, 5, 11, and 12) (38.5%) had a branch retinal vein occlusion.

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Slight vitreous hemorrhage was observed in the early postoperative period in 1 (7.7%) of the 13 patients but cleared spontaneously in 3 weeks. A small subretinal hemorrhage was present at the radial optic neurotomy site in 2 patients (15.3%). After surgery, nuclear sclerosis developed in 9 patients (69%) and retinal pigment epithelial changes were observed in 3 patients (23%). Clinical improvement in macular edema and hemorrhages was observed in all of the patients (Figure 1 and Figure 2).

Postoperative VA ranged from 20/100 to 20/25 (median, 20/50). The difference between preoperative and postoperative VAs was statistically significant \((P<.01)\). Nine patients (69%) had improved BCVA with 2 or more Snellen lines of vision gained, and 4 patients (30.8%) demonstrated improvement of 4 or more Snellen lines. No patient had a postoperative decrease in VA. In 3 patients (patients 5, 9, and 12), final VA remained unchanged because of retinal pigment epithelium atrophy secondary to chronic macular edema or subretinal hemorrhage.

Postoperative macular edema ranged from 171 to 390 \(\mu\)m (median, 252 \(\mu\)m). Median decrease was 306 \(\mu\)m. Visual acuity recovery was statistically related to the decrease in macular edema \((P=.02; \rho=-0.62)\) (Figure 3).

In 6 patients (46.1%), postoperative retinochoroidal shunts developed at the radial optic neurotomy site. The group of patients with retinochoroidal shunts showed a tendency to achieve a better mean final VA than did those in whom no collateral vessels were observed (mean final VA of 20/40 in the group with collateral vessels vs a VA of 20/50 in the group without collateral vessels), although this difference was not statistically significant \((P>.05)\).

Retinal neovascularization developed in 1 patient (patient 3) and was managed with panretinal laser photocoagulation in the corresponding hemiretina. No iris neovascularization was observed by the end of follow-up.

**COMMENT**

Hemicentral retinal vein occlusion is 1 of 2 types of retinal vein occlusion, together with hemispheric retinal vein occlusion, that affect half of the retinal extension. According to Mann, retinal vein occlusion, the hyaloid artery enters the optic stalk initially with-
out an accompanying vein, which appears in the third month of intrauterine life as 2 vascular channels at either side of the artery. Usually 1 of the 2 venous channels disappears before birth, leaving the central retinal vein as 1 trunk. However, the embryonic pattern may persist, and in 20% of the cases in which it does, HCRVO may occur as a result of occlusion of 1 of these 2 trunks. As reported by others, risk factors observed in our patients included hypertension, primary open-angle glaucoma, and diabetes mellitus. These risk factors are also associated with CRVO. In our series, 4 (30%) of 13 patients were diagnosed as having primary open-angle glaucoma, values similar to those recently reported in the literature. Only 1 patient had altered thrombophilia test results, which corresponded to primary antiphospholipid antibody syndrome.

The proposed management of HCRVO has been similar to that for CRVO. Panretinal photocoagulation...
and laser-induced chorioretinal anastomosis have been used.

Considering natural evolution, Hayreh and Hayreh,1 in their series of patients with HCRVO, observed stabilization of initial VA in most patients (61%), improved VA in 22%, and worsening of initial VA in 17% after a mean follow-up of 15 months. Moreover, a mean of 67% of patients exhibited chronic cystoid changes in the macula, and in patients in whom macular edema resolved, it did so during the first 3 to 5 months. Chopdar3,13 observed similar visual results: of 11 patients studied, 7 (63.6%) maintained VA as at the first examination and 4 patients (36.3%) gained 1 or more Snellen lines of VA. Mean follow-up was 7.8 months (range, 2-18 months), and in 50% of patients, follow-up was less than 6 months. Initial and final VA in that series of patients did not vary significantly, and in one third of those patients the initial VA was better than 20/60.

In our series, radial optic neurotomy was performed in an attempt to achieve an effect similar to that observed in CRVO. Macular thickness as measured using OCT clearly improved in all patients, and VA increased by 2 or more Snellen lines in 69% of the patients and by 4 or more Snellen lines in 30.8% after radial optic neurotomy. In most patients (70%), venous outflow improved in the postoperative period; the remainder were those with longer duration of symptoms (≥60 days). Radial optic neurotomy induced chorioretinal anastomosis in 41% of the patients after a mean of 6 weeks; this effect had been previously observed in pilot studies using this procedure in patients with CRVO.7-10 To our knowledge, there is no report in the literature on the management of macular edema secondary to HCRVO with radial optic neurotomy, apart from an isolated case reported by Weizer et al.16

We believe that improvement in our patients may have occurred by means of different mechanisms. First, proposed mechanical pressure exerted on the hemicentral retinal vein in the optic nerve was relieved. Second, we used vitrectomy and posterior hyaloid peeling, which have experimentally proved to decrease macular edema; most probably, the exchange between the retina and vitreous cavity after vitrectomy is easier and helps decrease macular edema. Third, new retinochoroidal shunts developed in 6 patients at the radial optic neurotomy site, creating a new venous outflow pathway. We believe the collateral vessels formed after neurotomy appear earlier and are more active in draining edema and hemorrhages than are those that appear spontaneously (this has been observed by several authors who have managed CRVO with radial optic neurotomy or those created after laser application). In addition, their location close to the optic nerve renders them more effective. The time of appearance of spontaneous cilioretinal collateral vessels is not well established, ranging from 2 to 25 months (mean, 6.7 months), according to Fuller et al in patients with CRVO, a duration much longer than that induced by radial optic neurotomy, which is about 6 weeks. Thus, we strongly believe that the anastomoses in these cases were directly related to radial optic neurotomy. In our study, patients in whom new retinochoroidal collateral vessels were observed showed a tendency to achieve better final visual outcome.

Intravitreal triamcinolone acetonide, which acts by down-regulating the vascular endothelial growth factor, would probably help to reduce macular edema during the immediate postoperative period and would be well associated with surgery because it addresses another of the mechanisms involved in HCRVO. We observed no choroidal neovascularization in the neurotomy site, peripapillary retinal detachment, or central artery occlusion, as previously reported in radial optic neurotomy for treatment of CRVO. That the technique proved useful in HCRVO, as it previously had in CRVO, and that newly formed retinochoroidal anastomoses appeared at the neurotomy site support the theory of a common pathogenesis of these 2 types of retinal vein occlusions.

This study has 2 main limitations: the small number of patients and the lack of a comparison group. However, considering the low prevalence of this disease, it can be deemed significant in that only 20 HCRVOs were diagnosed in a considerable series of retinal vein occlusions, and among those, only the patients with the worst initial VA were included. Thus, without a randomized, controlled trial and more patients, the efficacy and safety of this procedure cannot be proved.

As these preliminary data suggest, radial optic neurotomy seems to be a potential treatment for selected HCRVOs, which seem to have better evolution than the natural history, probably owing to the more rapid appearance of retinochoroidal collateral vessels, which promote faster resolution of macular edema and may protect against neovascular complications.

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Author Contributions: Dr Garcia-Arumi had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis.

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REFERENCES