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Long-term clinical outcome of radial optic neurotomy

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ABSTRACT

Purpose: To study the long-term clinical outcome through assessment of anatomical and functional results, as well as complications of eyes affected with central retinal vein occlusion (CRVO) that underwent radial optic neurotomy (RON).

Methods: Retrospective, observational and descriptive study of 47 eyes corresponding to 47 patients affected by CRVO. All the eyes underwent RON performed by the same surgeon since 2002. The main assessed variables were visual acuity (VA), intraocular pressure (IOP), presence of iris neovascularization and opticociliary veins, vascular recanalization and complications derived from this pathological entity.

Results: Surgery was performed in 47 eyes, 21 of them (44.7%) were right sided and 26 left sided (55.3%). Mean age was 58.97 years. Mean post-surgical follow-up was 32.15 months. A total of 70.2% of the patients experienced stabilization or VA improvement, 23.4% iridian neovascularisation and 42.6% developed opticociliary veins in the head of the optical nerve.

Conclusions: It is noticeable that in selected cases, RON produces a quick resolution of the retinal haemorrhage and papillary congestion and may improve the retinal perfusion. Long-term benefits are stabilization or improvement of the VA and a reduction in complications on the natural history in CRVO.

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Palabras clave:
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Evolución clínica de la neurotomía óptica radial a largo plazo

RESUMEN

Objetivo: Estudiar la evolución clínica a largo plazo de los ojos afectos de oclusión de la vena central de la retina (OVCR) intervenidos con neurotomía óptica radial (NOR), analizando los resultados anatómicos y funcionales de estos ojos y sus complicaciones.

Métodos: Estudio retrospectivo, observacional y descriptivo de 47 ojos correspondientes a 47 pacientes afectos de OVCR. Todos ellos fueron intervenidos con NOR, desde el año 2002 y por el mismo cirujano. Las variables principales analizadas fueron la agudeza visual (AV), la presión intraocular (PIO), la presencia o no de neovascularización del iris, de opticociliares y de recanalización vascular, y las principales complicaciones derivadas del cuadro ocular.

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**Introduction**

Central retinal vein occlusion (CRVO) is a frequent retinal vasculopathy which could cause significant ocular morbidity. It usually affects males and females equally and occurs mainly in populations over 50.\(^1,2\) According to the Central Vein Occlusion Study (CVOS) visual acuity (VA) at onset is an important prognostic indicator for the final VA.\(^1,3\)

About 50-70% of the patients who develop CRVO exhibit cardiovascular risk factors. The Eye Disease Case-Control study found an increased risk for developing any type of CRVO in patients with systemic arterial hypertension (AHT) and diabetes mellitus (DM).\(^4\) Those under 60 could have a greater association with blood hypercoagulability conditions and inflammatory problems.\(^5\) Identification and treatment of systemic vascular risk factors such as AHT and DM are very important in patients with OVCR.\(^6\) It is crucial to perform a strict follow-up of these patients due to the possibility of exhibiting neovascularization of the iris or chamber angle.

Various treatments, including observation, induction of chorio-retinal venous anastomosis with laser, intravitreous plasminogen tissue activator, intravitreal injections of triamcinolone acetonide,\(^7\) laser photocoagulation and recently anti-angiogenic drugs for reducing macular edema associated to OVCR\(^8\) have been proposed for managing CRVO without a great deal of success in what concerns functional improvement of the treated eyes.

The pars plana vitrectomy (PPV) surgical technique is utilized to address the complications of CRVO and to attempt to alter the natural evolution of the disease.\(^9\)

CRVO occurs due to the occlusion of the main trunk of the central retina vein at the level of the cribriform plate or close to it.\(^10\)

Radial optic neurotomy (RON), proposed by Opremcak, consists in combining PPV with a transvitreal incision of the nasal scleral ring to release the pressure on the central retinal vein at the level of the scleral exit and allow an increase of venous flow as well as the release of the thrombus.\(^11,12\)

The objective of the present paper is to study the long term clinical evolution of eyes affected by CRVO intervened with RON, analysing the anatomic and functional results of these eyes and their complications.

**Material and methods**

A retrospective, observational and descriptive study of 47 eyes belonging to 47 patients affected by CRVO.

The inclusion criteria were as follows: initial VA <0,3, absence of other associated retinal vasculopathies, absence of treatment with laser photocoagulation and vitreous hemorrhage and absence of neovascularization secondary to CRVO.

All the patients included in the study were submitted to a slit lamp assessment, determination of intraocular pressure (IOP), ocular fundus assessment, optic coherence tomography (OCT) and fluorescein angiography (FAG) before and after the intervention. All were intervened with RON from the year 2002 and by the same surgeon.

The surgical technique consisted in performing a complete 20-gauge PPV, dissection of the posterior hyaloids and optical radial neurotomy in nasal quadrants of a single section (fig. 1). The control visits were on days 1, 3, 7 and 30. Subsequently in months 3, 6, 9 and 12 after the intervention. In the post-op tobramycine and dexamethasone eyedrops 4 times a day during 15 days were prescribed.

**Resultados:** Se intervinieron 47 ojos de los cuales 21 (44,7%) fueron derechos (OD) y 26 (55,3%) izquierdos (OI). La edad media fue de 58,97 años. Con un seguimiento medio tras la NOR de 32,15 meses, un 70,2% de los pacientes tuvo una estabilización o mejoría de la AV, un 23,4% una neovascularización iridiana y un 42,6% desarrolló opticociliares en la cabeza del nervio óptico.

**Conclusiones:** Observamos que la NOR, en casos seleccionados, ayuda a una rápida resolución de la hemorragia intrarretiniana y de la congestión de la papila y puede mejorar la perfusión retiniana. A largo plazo estabiliza e incluso aumenta la AV, disminuyendo así el número de complicaciones a las que conduce la historia natural de la OVCR.

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All the patients were informed about the most important aspects of the surgical procedure. The main variables analyzed were VA, IOP, presence of iris neovascularization, of opticociliary and vascular recanalization and the main complications derived from the ocular condition. The statistical analysis of the study consisted in descriptive and inferential statistics which allowed us to compare hypotheses with different variables. Data was processed with SPSS- Windows 13.0 software (SPSS Inc., Chicago, USA). An alpha error of 0.05 was assumed. The comparison of VA and IOP before and after the treatment was made with the Wilcoxon non-parametric statistical test.

Results

Forty-seven eyes were intervened, of which 21 (44.7%) were right eyes (RE) and 26 (55.3%) left eyes (LE). Of all the patients, 19 (40.4%) were female and 28 (59.6%) were male. The mean age was of 58.97 years (standard deviation [SD] 13.76). The type of CRVO exhibited by the patients was: 23 (48.9%) ischemia > 10 disc diameters (DD), 7 (14.9%) ischemia < 10 DD, 3 (6.4%) nondetermined and 14 (29.8%) edematous.

The main risk factors were AHT (44.6%), DM (10.6%), hypercholesterolemia (8.5%), open angle glaucoma (10.6%), blood dyscrasia (8.5%) and vasculitis (2.1%), with many exhibiting several associated risk factors at the same time. 16.1% of the patients did not exhibit any risk factor (fig. 2).

The initial mean VA determined with Snellen optotypes was 0.115 (SD 0.10) (fig. 3). The mean final VA after the RON was of 0.1619 (SD 0.217) without finding, in this increase, statistically significant differences (P>0.05). Two patients, with 52 months follow-up, who started with a VA of 0.1 and 0.2, after the RON reached a VA of 0.8 and 0.9 respectively (fig. 4).

The initial IOP was of 15.94 mmHg (SD 4.82). The final IOP was of 16.85 mmHg (SD 7.34). The difference between IOP values was not statistically significant (P>0.05). The mean time from CRVO up to the RON was of 2.90 months (SD 3.39).

The mean follow-up time and evolution of our patients after RON was of 32.15 months (SD 21.11) with a maximum of 84 months.

The presence of opticociliaries was observed in 42.6% of the eyes (fig. 5). 61.7% of the eyes exhibited complete complete vascular recanalization, un 12.8% partial, and in 25.5% no recanalization determined by FAG was observed.

23.4% off the patients exhibited iridian neovascularization that was treated with panretinophotocoagulation.

Figure 2 – Columns graph: risk factors for the obstruction of the central retinal vein. DISCRAS SANG: blood discrasia; DM: diabetes mellitus; GL. ANG ABRTO: open angle glaucoma; HCOLST: hypercolesterolemia; AHT: arterial hypertension; VASC: vasculitis.

Figure 3 – Box diagram: initial visual acuity prior to the intervention.
In 90% of our patients residual diffuse macular edema was observed as determined by OCT. The remaining 10% who did not exhibit said condition reached a VA > 0.7. The main complications derived from the ocular pathology after RON were the presence of hemovitreous (21.3%), ocular ischemia (8.5%), cataract (17.0%), retina detachment (4.2%), subretinal hemorrhage (2.1%) (fig. 6) or none (46.9%) (fig. 7).

Two eyes (4.2%) exhibited phthisis bulbi due to terminal neovascular glaucoma.

Discussion

CRVO is the second most frequent retinal vascular pathology and can lead to severely diminished VA. Population-based studies indicate a CRVO prevalence of 0.1% - 0.4%.13

The main cause of reduced VA in CRVO is the presence of macular edema and the most important complication is neovascular glaucoma due to peripheral ischemia, which can develop in the course of this disease. The initial VA is the most important prognostic value and is related to the presence of ischemia and of course with the degree of macular edema.

The physiopathology of CRVO is not entirely known. Histopathological studies of enucleated eyes due to CRVO carried out by Green et al in 1981 demonstrated the presence of a thrombus that occluded the clearance of the central retinal vein at the level of the cribriform plate or close to it. This finding suggests that the anatomical variations at the level of the cribriform plate could account for the development of CRVO. Within the retrolaminar portion of the optic nerve, the central retinal vein and artery run parallel to each other in a common tissular sheath. Hemodynamic alterations can cause stagnation in the flow and facilitate the formation of thrombii in the central retinal vein.10

Opremcak et al proposed NOR.11 This technique consists in performing PFV and an incision at the level of the second cranial pair, the nasal scleral ring, to release the pressure on the central retinal vein at the level of the scleral exit. This procedure addresses the compartmental syndrome which can exist in these eyes when the central retinal vein, the central
retinal artery and the optic nerve pass through an area having a diameter of 1.5 mm.

When performing RON the major retinal vessels must be avoided. To this end it is useful to perform a FAG study prior to surgery to decide the location of the incision. A radial orientation of the incision is applied to avoid sectioning the nervous fibres. Complications such as intra-op hemorrhage can be controlled by means of temporarily raising IOP.

Opremcak studied 117 eyes affected by CRVO in which RON was performed. A clinical improvement was observed in the retinal hemorrhae and venous congestion.12 71% of the patients exhibited improvement in their VA values. Anterior segment neovascularization was observed in 6% of the patients and, as a result of this, their VA diminished.

In the series presented by García-Arumí et al, 57% of the 14 eyes prospectively intervened with RON gained one VA line and the visual recovery was significantly related with macular edema reduction. Six eyes developed post-op chorioretinal anastomosis adjacent to RON with a tendency towards improved final VA in comparison with those who did not exhibit anastomosis due to allowing a more active drainage of the retinal edema and the hemorrhage.13 These results are similar to those of our study in which, even though 63.8% of patients exhibited ischemic CRVO, in 50% of cases there was a significant VA improvement after RON. This VA is determined by the persistence of macular edema.

The mean follow-up of our study was of 32.15 months with a maximum of 84 months. In 42.6% we observed the presence of opticocilliaries in the optic nerve, with a clear link to the stabilization or considerable improvement of the final VA. In our series we also observed an inverted relationship concerning the appearance of rubeosis in the iris and the presence of opticocilliaries. Accordingly, the CRVO patients treated with RON and with the appearance of opticocilliaries exhibit a lower probability of developing iris rubeosis.

In addition, the improved VA in some of our patients could be explained by the release of the mechanical pressure exerted on the vein. The effects of PPV and dissection of the posterior hyaloid could also contribute. PPV increases retinal oxygenation and therefore enhances the improvement of the ocular condition and reduces the risk of retinal neovascularization and macular edema.14

In our study we observed angiographic vascular recanalization in 61.7% of the eyes after RON. In the eyes which exhibited opticocilliaries there was an improvement of recanalization, explained on the basis of the theoretical relaxation of the insertion ring produced by RON, with an improved drainage venous circulation.

In a study of 14 eyes affected by CRVO and intervened with RON and a mean follow-up of 24 months, Binder et al concluded that considering the slow development of CRVO it is difficult to define the best time to perform the surgical treatment.15 It might be reasonable to assume that, if the treatment is performed as early as possible, the irreversible damages derived from ocular ischemia might be avoided. However, due to the doubtful benefits and the known risks of this surgery, it is preferable to initially wait for a spontaneous improvement of the condition. In our study between CRVO and the beginning of the treatment there is a mean delay of about 3 months. We are of the opinion that RON has a better effect when performed within the first month of CRVO.

In a series of 63 patients, Opremcak et al did not find benefits in associating an intravitreal triamcinolone injection after RON for resolving the OVCR macular edema.16

At present, antiangiogenic drugs have been proposed for managing macular edema after CRVO with good results in the diminishment of macular edema and the improvement of VA. Even so, its effect is temporary and several injections must be made to maintain the response to the treatment, and these reinjections are not as efficient as the initial one. Accordingly, in this type of CRVO cases the long-term results are uncertain. Triamcinolone produces an even greater initial reduction of macular edema although repeated injections lead to increased IOP and the emergence of cataracts. For this reason, antiangiogenic drugs are currently preferred.17 In our experience, these could be a supplement to RON for the stabilization and resolution of the macular edema, although there are doubts about their anticongestive action because it could diminish the percentage of permeabilization of the opticocilliaries at the level of the II pair.

After 3 years follow-up of patients with CRVO, it was observed in CVOS that the natural history of the disease lead 80% of the patients to exhibit diminished VA. 44% of patients developed neovascularization in the anterior segment and only 5% of the patients exhibited opticocilliaries.3

Comparing the natural history of said patients with those of our study, wherein after RON and a mean follow-up of 32.15 months, 70.2% of the patients stabilized or improved their VA, 23.4% exhibited iridian neovascularization and 42.6% developed opticocilliaries in the head of the optic nerve, we observed how the results are better than those that would be obtained with the natural history of this disease in patients that debut with an initial VA line comparable to the patients included in our series.

By way of conclusion and even though this is a retrospective study, we observed how RON facilitates a rapid resolution of intraretinal hemorrhage and papillary congestion as well as a probable improvement of retinal perfusion. In the long term, it stabilizes and even increases VA. It diminishes the number of complications derived from the natural history of CRVO such as neovascularization of the iris and angle, and neovascular glaucoma.

We believe that in selected cases RON is a good treatment that provides good anatomic and functional results in eyes with CRVO.

Conflict of interest

The authors declare they have no conflict of interest.

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