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Macular microcirculation blood flow after pars plana vitrectomy with silicone oil tamponade

Przepływ krwi w mikrokrążeniu plamki po witrektomii przez pars plana z tamponadą olejem silikonowym

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Summary:

Purpose: To assess the macular microcirculation blood flow with Doppler laser scanning (HRF – Heidelberg Retinal Flowmeter), in patients with complicated rhegmatogenous retinal detachment (RRD), after pars plana vitrectomy (PPV), with silicone oil tamponade.

Material and methods: Eleven patients (6 males and 5 females), aged 38-64 years, mean age: 52.4 years, with unilateral macula-on complicated RRD were included in a study. In all cases conventional (20-gauge) pars plana vitrectomy with silicone oil tamponade was performed. Control group consists of the fellow eyes.

Results: In the early postoperative period (1-3 days after surgery), in all operated eyes the mean values of macular microcirculation blood flow were significantly reduced in the comparison with those of the control eyes ($p = 0.01$). The reduction of mean values of macular microcirculation blood flow was still observed in all silicone-oil-filled eyes one month after surgery as compared to the contralateral eyes ($p = 0.01$). There was no correlation between the values of macular microcirculation blood flow and the duration of RRD, baseline BCVA, refractive error, number of retinal tears, and the patient age.

Conclusions: The preliminary results of this study suggest that PPV with silicone oil tamponade influences over the retinal blood flow. We have observed that silicone oil may have a negative long-term effect on the retinal microcirculation as it was noted one month after surgery.

Słowa kluczowe:

przepływ krwi w mikrokrążeniu plamki, witrektomia przez pars plana, tamponada olejem silikonowym.

Key words:

macular microcirculation blood flow, pars plana vitrectomy, silicone oil tamponade.

Introduction

Silicone oil has established itself as an internal tamponade in the treatment of complicated retinal detachments. It has different viscosity and gravity in comparison to the vitreous, thus it is postulated that it may influence on the retinal blood flow. There are many methods of measurement of the ocular blood flow: color Doppler ultrasonography, Doppler velocimetry, the laser speckle method, pulsatile ocular blood flow technique and videofluorescence angiography (1-6). However, the evaluation of the macular microcirculation by these techniques is difficult and inaccurate. Heidelberg retina flowmeter (HRF), which combines the technique of laser Doppler flowmetry with laser scanning technology, can measure the retinal microcirculation blood flow. We found only two studies about the evaluation of retinal microcirculation blood flow using Doppler laser scanning in patients with RRD who underwent the pars plana vitrectomy with silicone oil tamponade (7,8).

The aim of this study was to assess the behavior of macular microcirculation blood flow in the silicone-oil-filled eyes and in the fellow eyes using Doppler laser scanning (HRF – Heidelberg Retinal Flowmeter).

Material and methods

Eleven patients with complicated rhegmatogenous retinal detachment (RRD) associated with severe proliferative vitreo-retinopathy (PVR-C) were included in a prospective study. There were 6 males and 5 females, aged 38 to 64 years, mean age: 52.4 years. Patients presenting eye diseases: glaucoma, diabetic retinopathy, retinal vasculitis, uveitis and systemic disorders such as systemic hypertension, cardiovascular diseases and diabetes were excluded. The duration of RRD ranged from 6 to 22 weeks; the mean time of duration of the symptoms was: 9.3 week.

The diagnosis of RRD was established based on an a standard ophthalmic examination which included: best corrected visual acuity (BCVA), intraocular pressure measurement, anterior segment examination and indirect ophthalmoscopy using a +90 D Volk lens and a Fison's indirect ophthalmoscope.

The BCVA in the affected eyes ranged from 0.3 to light projection (LP) and in the fellow eyes from 1.0 to hand movements. Refraction of the affected eyes ranged from +1.00 D to -16.00 D and in the fellow eyes from +2.00 D to -18.00 D. The intraocular pressure in the affected eyes was: 10.3 ± 2.8 mmHg

and in the fellow eyes: 15.2 ± 2.2 mmHg. The extent of RRD ranged from 8 clock hours to 12 clock hours (mean: 9 clock hours), and in all eyes RRD involved the macula. In all cases the retinal breaks were identified; there was a single retinal break in 7 eyes and in 4 the number of retinal breaks ranged from 2 to 3. Severity of PVR C extended from 5 to 12 of clock hours of retina. In 6 eyes RRD was associated with degenerative myopia, in one eye RRD developed as a result of a complicated cataract surgery and in 4 patients RRD developed as a result of a blunt ocular trauma or a head trauma. In 5 cases with high myopia the peripheral vitreo-retinal degenerations (lattice and snail-track degenerations), were present. Three eyes with posttraumatic RRD demonstrated intravitreal and/ or retinal haemorrhages.

In all cases a standard three ports pars plana vitrectomy (20-gauge) with drainage of subretinal fluid, peeling of epiretinal membranes, endolasertherapy and silicone oil endotamponade (5500) was performed. At the end of the surgery the retina was attached in all operated eyes.

The tissue blood flow in the macular area was measured using a scanning laser flowmeter (Heidelberg Retina Flowmeter, Heidelberg, Germany). The measurement area included a zone of $10 \times 2.5^\circ$, that equals to 2.8×0.7 mm. During each measurement the foveola was located in the central part of the scanned area. Measurements were performed at least three times for the macular area. The macular blood flow was measured 1-3 days and then one month after surgery. The results of microcirculation blood flow were presented in arbitrary units – AU. The calculation of macular capillary blood flow was performed with AFFPIA program (Automatic Full-Field Perfusion Image Analyzer). The differences in macular blood flow between affected and contralateral eyes were statistically analyzed using an unpaired t-Student test for independent trials. Correlations between macular blood flow and clinical factors such as age, duration and extent of RRD were determined by multiple regression analysis. In order to evaluate the influence of surgical factors: type of surgical procedure unpaired t-Student test was used. A probability value of less than 0.05 was considered to be statistically significant for all statistical analysis.

Control group consists of the 11 fellow eyes, 6 of them showed no pathology within the macular region, while 5 demonstrated the presence of pigment mottling.

Results

In the early postoperative period in eyes with RRD the mean values of macular microcirculation blood flow were significantly

reduced in the comparison with those of the fellow control eyes ($p = 0.01$). The reduction of mean values of macular microcirculation blood flow was still observed in all silicone-oil-filled eyes one months after surgery as compared to the contralateral eyes ($p = 0.01$). The macular microcirculation blood flow rates in the early postoperative period and one month after surgery in silicone-oil-filled eyes and in contralateral eyes are shown in table I.

One month after surgery the BCVA was maintained at baseline levels in 4 cases, improved in other 4 (by 1-3 lines on Snellen charts), and deteriorated in 3 patients. The deterioration of BCVA in 3 eyes after PPV was associated with a macular pucker formation. In all eyes we did not find a correlation between the BCVA changes after surgery and the values of macular blood flow. There was no correlation between the values of macular microcirculation blood flow and the duration of RRD, refractive error, number of retinal tears and the patient age.

Discussion

Based on literature it has been known that RRD and various scleral buckling procedures influence the ocular blood flow. It has been known that in some cases, in spite of good anatomical results of conventional RRD surgery, the vision might be affected. It is postulated that this complication may be associated with haemodynamic changes in ocular circulation followed by RRD conventional surgery. Compression on the peripheral vasculature by indentation caused by the scleral buckle or encircling element might be responsible for the alterations in ocular blood supply (5,9,10). However, there is scant information about the evaluation of the retinal microcirculation blood flow in patients with RRD after primary pars plana vitrectomy with silicone oil tamponade. Herbert et al. reported in a group of 5 patients a central scotoma commencing during silicone oil tamponade (11). The mean duration of oil in these eye was 2.7 months when the scotoma was noted by the patient. After oil removal, vision remained still affected. The authors found macular dysfunction in pattern electroretinography in four patients, while fluorescein angiography and optical coherence tomography (OCT) showed no abnormalities. The same observations were described by la Cour et al. (12).

Gray et al. using fluorescein angiography presented signs of sluggish or absent blood flow in retinal arterioles laying in close proximity to the silicone oil, and the arterioles themselves appeared narrowed (13). It is suggested that silicone oil may have a long-term effect on the retinal vasculature, owing either

	Mean values of macular blood flow in the early postoperative period/ Średnie wartości przepływu krwi w mikrokrążeniu plamki we wczesnym okresie pooperacyjnym	Mean values of macular blood flow one month after surgery/ Średnie wartości przepływu krwi w mikrokrążeniu plamki 1 miesiąc po operacji
Silicone-oil-filled eyes (N = 11)	256.5 ± 92.6 AU	286.6 ± 67.8 AU
Contralateral eyes (N = 11)	597.7 ± 93.9 AU	603.6 ± 103.1 AU

Tab. I. The macular microcirculation blood flow rates in the early postoperative period and one month after surgery in silicone-oil-filled eyes and in contralateral eyes.

Tab. I. Ocena przepływu krwi w mikrokrążeniu plamki we wczesnym okresie pooperacyjnym i 1 miesiąc po wprowadzeniu oleju silikonowego do gałek ocznych oraz w grupie kontrolnej.

to direct vascular damage, secondary to damage to the neuroretina, or to the silicone oil preventing diffusion of oxygen into the vitreous cavity. Studies in which the laser Doppler method was used also showed that the vitreoretinal surgery with silicone oil tamponade influence the fundus blood flow (7,8). In our group of patients using HRF technique we noticed reduction in the macular blood flow in all affected eyes 1-3 days after pp vitrectomy with silicone oil endotamponade. The same observations were published by other investigators. Chen et al. (7) in a group of 34 eyes having undertaken vitreoretinal surgery and in 28 eyes scleral buckling surgery, demonstrated that the mean retina and optic nerve head blood flow in the postoperative RRD eyes were reduced in the comparison with those of the fellow control eyes. They also found that ocular microcirculation of silicone oil tamponade eyes was reduced more than that in the eye that underwent conventional retinal detachment surgery. Effert et al. (8) measured the arteriovenous passage time, which is a parameter for the retinal microcirculation, in the silicone-oil-filled eye and in the contralateral eye in 14 cases using a laser scan ophthalmoscope at 3-5 days after surgery. In all cases they found a prolonged arteriovenous passage time in the silicone-oil-filled eye in comparison with the contralateral eye ($p < 0.01$).

Four weeks after surgery in our group of patients the reduction of mean values of macular microcirculation blood flow was still observed in all silicone-oil-filled eyes as compared to the contralateral eyes ($p = 0.01$). This observation indicates that the microcirculation is worsened also one month after surgery. This finding is consistent with a report by Gray et al. (13) and Herbert et al. (11); the authors demonstrated the long-term retinal effects of intravitreal liquid silicone on retinal microcirculation blood flow and ERG results, as mentioned above.

We found no statistically significant difference between the degree of disturbances of the macular microcirculation blood flow and the extent of RRD, the duration of RRD, refractive error, number of retinal tears and the patient age. The same results were presented by Eshita et al.; the authors showed that the preoperative a/f ratio (affected to fellow eye macular blood flow ratio), had a significant correlation only with extent of RRD (14).

Concluding, the results of our study suggest that PPV with silicone oil endotamponade influences the retinal blood flow. We have observed that silicone oil may have a long-term effect on the retinal microcirculation as it was noted one month after surgery.

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