Evaluation of ocular pulse amplitude changes after the retinal detachment repair

Miroslav Jeremic, Igor Kovacevic, Jelena Vasiljevic, Tanja Kalezic, Marija Bozic

Purpose: The study was conducted to determine the ocular pulse amplitude (OPA) changes, measured with a dynamic contour tonometer (DCT), after surgical retinal detachment repair. Methods: This was a prospective and comparative study. Thirty patients (30 eyes) who had undergone uncomplicated unilateral scleral buckling and encircling procedures for quadrant or half-retinal rhegmatogenous retinal detachment were referred for DCT one day before the surgery was performed, on the 1st, 7th, and 30th postoperative day. Methods of descriptive (arithmetical mean, standard deviation) and analytical statistics (analysis of variance) were used to analyze the data and evaluate the significance of the difference. A value of \( P \) less than 0.05 was considered statistically significant. The data were evaluated for normality with the single-sample Kolmogorov–Smirnov test. Results: OPA values decreased significantly after scleral buckling procedures \( (p < 0.0001) \), but regained near to preoperative values one month after the surgery. Conclusion: OPA tends to decrease after retinal detachment surgery. Restoring patients' vision with scleral buckling and encircling procedures gives early changes in blood supply to the choroid and ocular nerve, and since OPA is an indirect parameter of choroidal vascularization, measuring these values can help make an insight into ocular hemodynamics.

Key words: Ocular pulse amplitude, retinal detachment, scleral buckling

Scleral buckling and encircling band surgery are surgical procedures for repairing rhegmatogenous retinal detachment that have been in use for over 50 years. The question of what happens with intraocular pressure (IOP), aqueous flow, and entire ocular blood flow after surgery arose in the 1980s[2-5] along with the interest in blood volume and ocular pulse amplitude (OPA) changes.[2-5] However, none of the published studies addressed OPA measured by the means of dynamic contour tonometry (DCT).

This was a prospective and comparative study in which we evaluated OPA changes after scleral buckling and encircling surgery. The study was approved by the local ethics committee, and informed consent according to the Declaration of Helsinki was obtained from each subject.

Methods

Thirty consecutive patients (30 eyes) who had undergone uncomplicated unilateral scleral buckling and encircling procedures for quadrant or half-retinal rhegmatogenous retinal detachment were referred for DCT one day before the surgery was performed, on the 1st, 7th, and 30th postoperative day. Retinal detachment surgery was performed under general anesthesia, and the same materials, silicone tire and encircling silicone band (Microvision Inc, USA) were used. The operation itself was done by two surgeons (I.K. and J.K.) by the same technique in all patients.

Exclusion criteria were as follows: glaucoma patients, any previous eye surgery, uveitis, or eye trauma history, and patients who experienced IOP rise after the surgery.

All patients underwent a complete ophthalmic examination, review of medical history, visual acuity testing (Snellen chart), applanation tonometry (Goldmann), OPA (baseline, 7 and 30 days after the surgery) measurement with DCT (DCT, Pascal, Ziemer Ophthalmic System AG, Switzerland), slit-lamp biomicroscopy, indirect ophthalmoscopy. Systemic blood pressure measurements were taken three times with a minimum 5-min interval between readings (Omron M3 Intellisense, automated manometer; Omron Healthcare, Kyoto, Japan), and the mean blood pressure was noted for each tested subject. The results are shown in Tables 1 and 2.

Before the treatment, 7 days, and 1 month after the treatment, OPA was measured. OPA of the untreated contra-lateral eye was used as a control. DCT measurements were taken in a sitting position, with topical anesthesia of the cornea (tetracaine 1.0%). All measurements were performed by one ophthalmologist (M.B.) according to the manufacturer's guidelines: at the same time of the day, in the morning (between 09:00 and 10:00 am), to avoid diurnal
fluctuations. Only readings with a quality index ("Q") of 1 or 2 were considered for analysis since the higher numbers of the Q index indicate lower measurement quality. The OPA was measured in the operated eye and the fellow control eye of each patient, and the mean value was calculated from three representative measurements.

Wilcoxon’s signed-rank test was used to compare the OPA in the operated eyes with those in the control eyes. Statistics were analyzed using SPSS software version 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). The data were given as mean values ± standard deviations (SDs). The Gaussian distribution of the parameters was tested using the Kolmogorov–Smirnov test. All tests were two-tailed, and the significance was set at 0.05.

Results

The study included 30 eyes of 30 patients (18 males, 12 females) with retinal detachment. The mean age was 57.17 ± 11.21 years (range 26–82). Descriptive statistics for the demographic and ocular characteristics are shown in Table 1.

The mean OPA values in operated eyes was significantly lower on day 7 (p << 0.01), but returned to almost preoperative values one month after the surgery. No significant differences were noted in OPA values in non-operated eyes.

Significant differences in OPA values between the operated and fellow eye were noted on day 1 (p < 0.05) and day 7 (p < 0.01), but no significant statistical difference was found between the two eyes of the same subject one month after the surgery.

The results are shown in Table 3 and Fig. 1.

Table 1: Demographics of tested subjects (SD standard deviation, F female, M male, RE right eye, LE left eye)

| Demographics        | Years±SD (range) |
|---------------------|------------------|
| Age                 | 57.12±11.21 (26-82) |
| Gender F/M          | 12/18            |
| Eye RE/LE           | 14/16            |

Table 2: Systemic blood pressure values and pulse (OPA ocular pulse amplitude)

| Measurements                  | OPA 0      | OPA 1      | OPA 7      | OPA 30     | P (analysis of variance) |
|-------------------------------|------------|------------|------------|------------|--------------------------|
| Systolic arterial pressure, mmHg, mean ±SD | 150.5±21.3 | 140.9±22.6 | 138.7±24.2 | 140.4±22.9 | 0.338                    |
| Diastolic arterial pressure, mmHg, mean ±SD    | 89.5±13.8  | 84.7±9.8   | 87.6±10.5  | 83.6±11.1  | 0.289                    |
| Heartbeat, beats/min           | 78.3±7.3   | 76.2±8.2   | 79.4±7.9   | 77.8±7.4   | 0.315                    |

Table 3: Tested values ANOVA

| eye            | OPA 0    | OPA 1    | OPA 7    | OPA 30   | P          |
|----------------|----------|----------|----------|----------|------------|
| operated       | 2.57±1.03| 2.36±0.84| 2.00±0.85| 2.49±0.87| P<0.05     |
| fellow         | 2.71±0.97| 2.67±1.09| 2.69±0.89| 2.74±1.03| P>0.01     |
| P              | P>0.01   | P<0.05   | P<0.01   | P>0.01   |            |

Discussion

Our results show that scleral buckling and encircling band procedures lead to a reduction of OPA values, which relatively quickly return to values measured in non-operated, control eyes. This is in accordance with the results of previous studies.\(^6\) OPA represents the difference between systolic and diastolic pressure, the extension of the pulsatile oscillations of the IOP during the cardiac cycle, and can in fact be considered an indirect indicator of the choroidal perfusion.

Scleral buckling and encircling procedures have been reported to lead to a decrease in the volume of the choroidal circulation. Yoshida et al.\(^7\) concluded that this decrease is a consequence of higher resistance in the choroidal circulation which occurs after retinal detachment surgery. However, in Yoshida et al.\(^7\) study, the choroidal circulation took as long as 12 months to return to the levels of the non-operated eye, whereas in our study, results show that this normalization of OPA happens much earlier. The reason for the difference in the results of these studies might be in the use of different techniques for determining OPA values. It is known that the most important ocular confounders for OPA values are initial IOP, ocular volume, and scleral rigidity.\(^8\) For the reason of bias, we excluded patients who experienced IOP rise after retinal detachment surgery. Scleral encircling procedures decrease the scleral rigidity of the operated eye but judging by our results...
we can assume that these changes are not long-term since the normalization of the OPA values has occurred just one month after the surgery.[9]

It is clear that retinal detachment repair surgery procedures do affect choroidal circulation, and it has been determined that remodeling of the choroidal circulation might contribute to the recovery of ocular hemodynamics after such surgery.[10]

**Conclusion**

Our results indicate that scleral buckling procedures together with encircling procedures lead to a decrease in OPA values and probably to a decrease in ocular blood flow because of decreased ophthalmic perfusion pressure. Although according to our results this decrease is a short-term change, retina surgeons should bear in mind that although beneficial to achieving retinal reattachment, retinal detachment repair techniques influence ocular blood flow.

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**Conflicts of interest**

There are no conflicts of interest.

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