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The Relationship between Low Ocular Perfusion Pressure with Acute Non-Arteritic Anterior Ischemic Optic Neuropathy

Xiaotang Wang, Tao Lei, Yong Wang and Runsheng Wang*

Department of Neurophthalmic Center, People's Hospital of Xibei University, Shaanxi Province, China

***Corresponding author:** Runsheng Wang, Department of Neurophthalmic Center, People's Hospital of Xibei University, Shaanxi Province, China, Email: wangrunsheng0602@126.com

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Abstract

Objective: To investigate the relationship between low ocular Perfusion Pressure (OPP) with Acute Non-Arteritic Anterior Ischemic Optic Neuropathy (ANAION).

Methods: Thirty-nine patients (39 eyes) with ANAION from July 2010 to December 2016 were retrospectively analysed. The 24-h Intraocular Pressure (IOP) in sitting position was measured by non-contact tonometer. The brachial artery Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were simultaneously measured by electrocardiogram monitor. The 24-h OPP was calculated according to the measured blood pressure and IOP: OPP=45% DBP-IOP. OPP<10 mmHg was defined as low OPP. Sudden visual acuity declining or visual field defect was recorded as the attack of ANAION. The correlation between low OPP and ANAION was analysed.

Results: The most common period of low OPP was period A (1-6 A.M). The occurrence of low OPP was higher in period A (17/29, 58.6%). Most common time period of ANAION was also period A (1-6 A.M). The incidence rate of ANAION was higher in period A (21/39, 53.8%). Correlation analysis showed that the period of low OPP was associated with the period of ANAION onset (r=0.61, P=0.002).

Conclusion: There was a significant clinical correlation between low OPP and ANAION. Period A (1-6 A.M) was the high-risk period for low OPP and ANAION. The occurrence of ANAION can be reduced by elevating the OPP to improve the blood perfusion of the anterior optic nerve.

Keywords: Ocular perfusion pressure; ANAION; Correlation; Blood pressure

Abbreviations

OPP: Ocular Perfusion Pressure; ANAION: Acute Non-Arteritic Anterior Ischemic Optic Neuropathy; IOP: Intraocular Pressure; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Introduction

Acute Non-Arteritic Anterior Ischemic Optic Neuropathy (ANAION) is the most common acute optic nerve disease in patients over 50 years old. The onset time of ANAION is often in the morning, with the clinical manifestations including sharp declining of visual acuity, edema of optic nerve head and quadrant or upper and lower (mostly horizontal) visual field defects associated with physiological blind spots[1-3]. Currently, the pathogenesis of ANAION is still not clear. Insufficient blood supply of the short posterior ciliary artery may be the main cause of ANAION. Acute non-perfusion or hypoperfusion is the hemodynamic basis for ANAION [4,5].

Materials and Methods

Patients

Thirty-nine patients with ANAION admitted to our hospital from July 2010 to December 2016 were collected. ANAION was diagnosed by analyzing the peri-disc nerve fiber thickness, visual field, visual electrophysiology and fundus fluorescein angiography:

1) Sudden vision acuity loss or visual field damage, no eye pain;

2) Relative afferent pupillary reflex disorder (+);

3) Paleness and unclear boundary in the localized or the overall optic disc;

4) Thickening of nerve fiber layer around optic disc;

5) Quadrantal visual field defect associated with physiological blind spot;

6) Low fluorescence in localized optic disc before and during the early arterial period. Inclusion criteria included diagnosed ANAION, detailed onset time of ANAION and blood pressure and intraocular pressure monitored for 24 hours. Exclusion criteria were included as follow. First, patients with POAG, optic neuritis, optic disc vasculitis, Leber hereditary optic neuropathy and drug-induced optic neuropathy were excluded. Second, patients with intracranial and intraorbital lesions causing vision acuity loss or

visual field damage by CT and MRI scanning were excluded. Third, patients with macular lesions, high myopia, refractive interstitial opacity, optic disc burial vitreous membrane warts and hypertension were excluded.

Blood pressure, Intraocular Pressure (IOP) and OPP

24-h IOP in the sitting position were measured by non-contact tonometer (nidek-2000, Japan). IOP was measured for 3 consecutive times and the average value of IOP was calculated. Goldmann tonometer was used to correct the results of two tonometers. The values measured by the two tonometers were normal. At the same time, the brachial Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in the sitting position were measured by electrocardiogram monitor (Mindry-AQ, shenzhen). Blood pressure and IOP were measured hourly for 24 hours.

Blood pressure and IOP of ANAION patients were recorded for 24 h. According to IOP and blood pressure, OPP was calculated: OPP=45% DBP-IOP [6,7]. 10 mmHg of Hayreh was the OPP risk value of anterior optic ischemia [8]. The OPP value ≤ 10 mmHg is determined as low OPP. Patients with low OPP at ≥ 2 points were confirmed as having low OPP. The onset time of ANAION patients was the time of visual acuity loss and/or visual field defect.

Low OPP and onset time in ANAION patients

Based on analyzing 24 h blood pressure, IOP and OPP of all patients with ANAION, it was found that 24 h or 12 h OPP were not lower than 10 mmHg but OPP was lower than 10 mmHg only at several time periods. The time when low OPP occurred was defined as the time point of low OPP. At the same time, the time of visual acuity loss and/or visual field defect was determined as the onset time of ANAION patients. For the convenience of observation and statistical analysis, the 24 hours were divided into four periods: period A (1-6 A.M), period B (6-12 A.M), period C (12-18 P.M) and period D (18-24 P.M).

Statistical analysis

The Spearman correlation was used to analyze the correlation between low OPP and ANAION. SPSS22.0 was used for statistical analysis and P<0.05 was statistically significant.

Results

The 39 patients with ANAION included 21 males (21 eyes) and 18 females (18 eyes). The mean age was 60.5 ± 2.3 years (range: 38 to 73 years). There were 7 cases with diabetes mellitus, 10 cases with myocardial ischemia and 10 cases with cerebral infarction. The onset time of ANAION ranged from 1 to 3 week. Time points of low OPP at least 2 were recorded in 29 cases (74.4%, 29/39).

Low OPP and onset of ANAION mostly occurred in the period from sleep at night to early morning **(Figure 1)**. The occurrence of low OPP was higher in period A (17 cases, 58.6%), followed by period C (5 cases, 17.2%). Twenty-one (53.8%) cases had ANAION attack in period A and ten (25.6%) cases in period C.

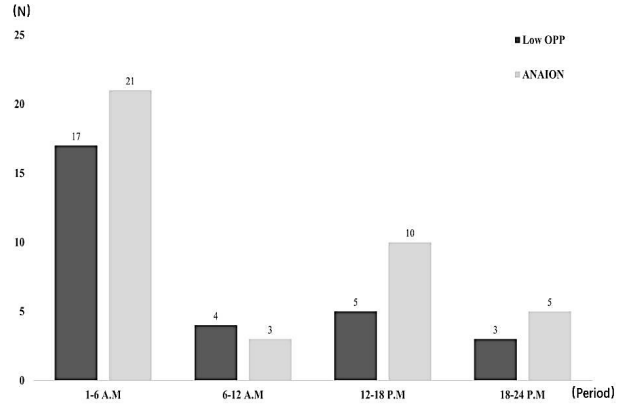

Figure 1: Low OPP and onset of ANAION in different time periods. Note: ( ) Low OPP ( ) ANAION.

The relationship between low OPP with ANAION is showed in **Table 1.** Spearman correlation analysis showed that the period of low OPP was associated with the period of ANAION onset (r=0.61, P=0.002).

Table 1: Correlation analysis of low OPP and onset of ANAION.

Time period	Low OPP（n, %）	Onset of ANAION（n, %）
A（1~6 Am）	17(58.6)	21(53.8)
B（6~12 Am）	4(13.8)	3(7.7)
C（12~18 Pm）	5(17.2)	10(25.6)
D（18~24 Pm）	3(10.3)	5(12.8)
r	0.61	
P	0.002	

Discussion

Low OPP is an important risk factor for ANAION. OPP is driving force of blood supply to the anterior optic nerve. Hayreh found that vessels in the papilla of optic nerve and choroidal membrane were not filled with blood when OPP was less than 10 mmHg by fundus fluorescein angiography [8]. Studies showed that ANAION was caused by multiple local and systemic risk factors such as small optic disc and superficial optic cup, insufficient blood supply of anterior optic nerve and vascular self-regulation disorder. Most of all, low OPP plays a major or important role in its pathogenesis [5,9-11].Although there is a lack of large scale prospective studies on the correlation between OPP and ANAION, low OPP is one of the risk factors for ANAION, which has been accepted by most scholars. In our study, there was a significant correlation between low OPP and onset of ANAION in the time period (r=0.61, P<0.05), which was consistent with relevant previous studies.

Period A (1-6 A.M) is the high-risk period for the incidence of low OPP and ANAION

In 1994, Hayrech proposed that the incidence of ANAION was related to the low diastolic blood pressure at night and the sharp decrease in anterior optic nerve perfusion caused by poor blood circulation in the posterior ciliary artery [12]. Wang et al. studied the blood pressure in 50 patients with ANAION and 50 healthy subjects and found that DBP in ANAION at night was lower than the control group [13]. Our study found that DBP in patients with ANAION significantly decreased compared with the control group ($P<0.05$), particularly in the whole period A. DBP could be reduced to 60 mmHg or lower. This was consistent with the research results by Hayrech and wang runsheng. IOP at night was significantly higher than during the daytime, and reached its highest level from deep sleep to wakefulness [14,15]. IOP increased significantly when the position changed from sitting to supine position or lateral position. IOP in the lateral position was higher than supine position [16,17]. Postural changing that caused IOP may be also an important risk factor for the onset of ANAION [9]. Therefore, low DBP at night, high IOP and the low OPP are the main reasons for the occurrence of ANAION in the period from falling asleep at night to getting up in the morning. OPP physiological circadian rhythm loss caused by ascular autonomic nerve regulation disordermay is also a part of the pathogenesis of ANAION [18-20].

Closely monitoring blood pressure and IOP in high-risk period for reducing the incidence of low OPP

When OPP excessively reduces, the time of DBP of the short posterior ciliary artery at the critical level exceeds its own compensation limit and tolerance. If the patients themselves have anatomic bases such as small optic disc and shallow optic cup, the small vessels in the narrow environment in front of the optic disc sieve plate are limited and not easy to self-regulate. At this time, ANAION is more likely to occur after prolonged hypo perfusion, which leads to optic nerve ischemia behind the optic nerve papilla and sieve plate. Therefore, for patients with small optic disc and superficial optic cup, night blood pressure, IOP and OPP should be closely monitored. If necessary, the OPP should be improved to increase the blood flow of anterior optic nerve and reduce the occurrence of ANAION (especially iatrogenic ANAION) [20,21]. The efficacy of this method could be evaluated by FFA, visual field, vision acuity and OCT.

Conclusion

In conclusion, low OPP was significantly associated with the incidence of ANAION. Period A (1-6 A.M) is the high-risk period for the occurrence of low OPP and ANAION. However, the clinical correlation between OPP and ANAION is still controversial. Therefore, we retrospectively analyzed the 24-h OPP of 39 patients with ANAION to investigate the clinical correlation between low OPP and the attack of ANAION.

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