Iris Arteriolar Diameters in Hypoxia and Hyperoxia: A Photographic Study in Albino Guinea Pigs

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The irides of albino guinea pigs were photographed, and the iris arteriolar diameters were measured with the animal breathing room air, 10% O2/90% N2, or 100% O2. The iris arterioles constrict significantly in hyperoxia and dilate in hypoxia. The average constriction in 100% O2 was 27% ± 8%, and the average dilatation in 10% oxygen was 34% ± 20%. Invest Ophthalmol Vis Sci 24:741-743, 1983

While hypoxia has been implicated in the pathogenesis of neovascularization in the eye, including rubeosis iridis,1,2 information has been lacking on the effects of hypoxia on the iris circulation. Do the iris vessels have an autoregulatory mechanism like the retinal circulation3-4 or do they behave passively like the choroid?5 In this study the diameter of iris arterioles in albino guinea pigs was measured to investigate how the iris arterioles react to hypoxia and hyperoxia.

Materials and Methods

Four adult albino guinea pigs (500-700 g) were anesthetized with intramuscular ketamine hydrochloride 40 mg/kg. The guinea pigs were positioned under an operating microscope (OPMI-6, Carl Zeiss, West Germany) and the iris viewed at X40 magnification. The iris vasculature was photographed at X4 magnification through the microscope with the animal breathing room air. A 90% N2/10% O2 gas mixture was given by a breathing mask at a flow rate of 2 liters/min. The iris vasculature was photographed after 1, 3, and 5 min of breathing 10% O2. The animal was then placed back in room air. In a similar fashion, irides of albino guinea pigs were photographed before and 1, 3, and 5 min after they started breathing 100% oxygen at one atmosphere pressure.

A ruler with 1 mm markings was photographed with the eyes and measured in a similar fashion to allow calculation of the blood vessel diameter in the photographs. No correction was made for the magnification due to the cornea. The photographs were projected onto a screen making the total magnification of the iris 130- to 150-fold. The diameters of the arterioles branching from the major arterial circle of the iris were measured. Selected segments of vessels were compared to the diameter of the same vessels segments after 1, 3, and 5 minutes of breathing 10% O2 or 100% O2. The measurements were repeated by two independent observers who were unaware of which experimental group each photograph belonged to. The difference between their measurements was found to be insignificant. Also, no significant difference was found between measurements made on films viewed under a microscope or projected onto a screen. Changes in pupil size were deemed insignificant.

Results

Hypoxia led to dilatation of the iris arterioles and hyperoxia led to constriction of the iris arterioles. Fifty-eight arteriolar segments were measured in the four albino guinea pigs. The mean arteriolar diameter (not corrected for corneal magnification) was measured to be 50 ± 12 μm (average ± one standard deviation) and ranged from 27 μm to 77 μm (Table 1). After breathing 10% O2 and 90% N2 for 5 min, the arteriolar diameter had increased 34 ± 20% (average ± standard deviation; n = 38) from the vessel diameter when the animal was breathing room air. This is a statistically significant change (P < 0.0005, Student's t-test). When the animal had breathed 100% oxygen for 5 min, the arteriolar diameter had increased 34 ± 20% (average ± standard deviation; n = 18, average ± one standard deviation). This is also a significant change (P < 0.0005, Student's t-test).
Table 1. The mean vessel diameter in room air and the mean percentage change after 5 min of hypoxic or hyperoxic conditions are presented. The number of measurements and standard deviations are given. The changes are statistically significant (P < 0.0005 Student's t-test).

<table>
<thead>
<tr>
<th>Mean vessel diameter*</th>
<th>Diameter increase after 5 min of breathing 90% N₂/10% O₂</th>
<th>Diameter decrease after 5 min of breathing 100% O₂</th>
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<tbody>
<tr>
<td>50 μm + 12 μm</td>
<td>34% ± 20% (n = 58)</td>
<td>27% ± 8% (n = 18)</td>
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* Not corrected for corneal magnification.

Figure 1 shows the iris of an albino guinea pig breathing room air, 10% and 100% oxygen. Figure 2 shows the change in iris arteriolar diameters when the animal is kept in hyperoxic and hypoxic conditions.

Discussion

These data indicate that the iris arterioles of the albino guinea pig dilate in hypoxic conditions and constrict in hyperoxic conditions. Presumably the arteriolar dilatation in hypoxia leads to an increase in iris blood flow and the arteriolar constriction in hyperoxia causes the iris blood flow to decrease. This study does not determine whether this is an autoregulatory response of the iris vasculature, or a response mediated by nerves or humoral factors. The iris vessels also regulate their diameter to compensate for changes in perfusion pressure and keep CO₂ tension constant.

The response of iris vessels to CO₂ and changes in perfusion pressure has been examined by biomicroscopy as well as using microspheres to measure blood flow. These studies also demonstrate the changes in diameter of iris vessels with changes in pupil size, and the importance of keeping pupil size unchanged between measurements, as was done in our study.

The clinical importance of iris vasodilatation in hypoxia is unclear. Vasodilatation in the iris has been reported to precede the development of rubeosis iridis and from this it appears that hypoxia may play a role. Vitrectomy and lensectomy produce anterior chamber hypoxia and those procedures also increase the risk of rubeosis iridis in diabetics. Thus, circumstantial evidence exists to link hypoxia...
Fig. 2. The graph demonstrates the relative change in arteriolar diameters in the iris of the albino guinea pig, which is breathing 10% O2 (90% N2) or 100% O2. The ordinate gives the arteriolar diameter divided by the arteriolar diameter in room air. All arteriolar segments are normalized to 1.0 in room air, and the relative change recorded after 1, 3, and 5 min of breathing either 10% O2 or 100% O2. The abscissa shows the time the animal has been breathing the experimental air mixture. The bars on the graph denote one standard deviation. Data from 38 measurements in 100% O2 and 18 measurements in 100% O2. The changes are statistically significant (P < 0.0005, student's t-test).

and vasodilatation with neovascularization in the iris, but much additional work is necessary to discover the exact relationship.19

Key words: iris, oxygen, blood flow, regulation of blood flow, rubeosis iridis

References