Relationship between retinal blood flow and arterial oxygen

Abstract

Retinal blood flow (RBV) increases in response to a reduction in oxygen (hypoxia) but decreases in response to increased oxygen (hyperoxia). However, the relationship between blood flow and the arterial partial pressure of oxygen has not been quantified and measured in the retina, particularly in the vascular reserve and resting states of the eye. The present study aimed to determine the limitations of the retinal vasculature by modelling the relationship between RBV and oxygen.

Retinal venular response measurements were performed in 13 subjects for various arterial gas compositions, with the arterial partial pressure of oxygen (P ET Co2) ranging from 50-0.05mmHg. Retinal venular response measurements were repeated before, using the Canon Kheen blood flow meter (Canon Inc., Tokyo, Japan) during the first visit, while the remainder were performed before laser-induced choroidal vasodilatation during the second visit. We determined that the relationship between RBV and P ET Co2 can be modelled as a combination of hyperbolic and linear functions. We conclude that RBV increases in response to oxygen consumption in arterial oxygen content or oxygenation levels used in the present study but can no longer compensate below a P ET Co2 of 50-0.05mmHg. These thresholds have a great vascular reserve of RBV. Increasing diameter (9.8% arteriolar and 21.2% venular area) with hyperoxia (400mmHg P ET Co2 P O2) and decreasing diameter (1.9% arteriolar and 13.2% venular area) with hypoxia (50mmHg P ET Co2, P O2) is the same extent. This indicates that the retinal blood flow is not the midpoint of the adjustment range at resting P O2 where sensitivity is minimum.

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Abstract

Key points:  Vascular reactivity, the response of the vessels to a vasodilatory stimulus such as hypoxia and hyperoxia, can be used to assess the vascular range of adjustment in which the vessels are able to compensate for changes in PaO2. Previous studies in the retina have not accurately quantified retinal vascular responses and precisely targeted multiple PaO2 stimuli at the same time as controlling the level of carbon dioxide, thus precluding them from modelling the relationship between retinal blood flow and oxygen. The present study modelled the relationship between retinal blood flow and PaO2, showing them to be a combined linear and hyperbolic function. This model demonstrates that the resting tonus of the vessels is at the mid-point and that they have great vascular range of adjustment, compensating for decreases in oxygen above a PaO2 of 10-15 mmHg but being limited below this threshold. Retinal blood flow (RBF) increases in response to a reduction in oxygen (hypoxia) but decreases in response to increased oxygen (hyperoxia). However, the relationship between blood flow and the arterial partial pressure of oxygen has not been quantified and modelled in the retina, particularly in the vascular reserve and resting tonus of the vessels. The present study aimed to determine the limitations of the retinal vasculature by modelling the relationship between RBF and oxygen. Retinal vascular responses were measured in 13 subjects for eight different blood gas conditions, with the end-dial partial pressure of oxygen (P ET CO2) ranging from 40-50 mmHg. Retinal vascular responses were measured repeatedly using the Canon laser blood flowmeter (Canon Inc., Tokyo, Japan) during the first visit and using Doppler spectral domain optical coherence tomography during the second visit. We determined that the relationship between RBF and PaO2 can be modelled as a combination of hyperbolic and linear functions. We concluded that RBF compensated for decreases in arterial oxygen content for all stages of hypoxia used in the present study but can no longer compensate below a PaO2 of 10-15 mmHg. These vessels have a great vascular range of adjustment, increasing diameter (15% arteriolar and 21% total versus area) with hypoxia (40 mmHg; P ET CO2; P < 0.001) and decreasing diameter (9.9% arteriolar and 23% total versus area) with hyperoxia (500 mmHg; P ET CO2; P < 0.001) to the same extent. This indicates that the resting tonus is near the mid-point of the adjustment ranges at resting PaO2 where sensitivity is maximum.  

References (47)