Relationship between retinal blood flow and arterial oxygen

By: Cheng, RW (Cheng, Richard W.)[1,2,3]; Yusof, F (Yusof, Firdaus)[1,3,5]; Tsui, E (Tsui, Edmund)[1]; Jong, M (Jong, Monica)[1,6]; Duffin, J (Duffin, James)[2,7,9]; Flanagan, JG (Flanagan, John G.)[1,4,8]; Fisher, JA (Fisher, Joseph A.)[2,7,9]; Hudson, C (Hudson, Chris)[1,3,4]

JOURNAL OF PHYSIOLOGY-LONDON
Volume: 594 Issue: 3 Pages: 625-640
DOI: 10.1113/JP271182
Published: FEB 1 2016
View Journal Information

Abstract

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-tidal partial pressure of oxygen (P ETC O2) ranging from 40-500mmHg. Retinal vascular response measurements were repeated twice; 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 P ETC O2 of 32-37mmHg. These vessels have a great vascular range of adjustment, increasing diameter (8.5% arteriolar and 21% total venous area) with hypoxia (40mmHg P ETC O2; P<0.001) and decreasing diameter (6.9% arteriolar and 23% total venous area) with hyperoxia (500mmHg P ETC O2; 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.

Keywords

KeyWords Plus: ISOCAPNIC HYPEROXIC PROVOCATION; VASCULAR REACTIVITY; SYSTEMIC HYPEROXIA; DIABETIC-RETINOPATHY; NITRIC-OXIDE; HYPOXIA; RAT; VASODILATION; RESPONSES; DIAMETER

Author Information

Reprint Address: Hudson, C (reprint author)
Univ Waterloo, Sch Optometry & Vis Sci, 200 Univ Avenue West, Waterloo, ON N2L 3G1, Canada.
Addresses:
[1] Toronto Western Hosp, Univ Hlth Network, Dept Ophthalmol & Vis Sci, Toronto, ON M5T 2S8, Canada
[2] Univ Toronto, Dept Physiol, Toronto, ON, Canada
[3] Univ Waterloo, Sch Optometry & Vis Sci, 200 Univ Avenue West, Waterloo, ON N2L 3G1, Canada
[4] Univ Toronto, Inst Med Sci, Toronto, ON, Canada
[5] Int Islamic Univ Malaysia, Dept Optometry & Visual Sci, Bandar Indera Mahkota, Pahang, Malaysia
[6] Univ New S Wales, Brien Holden Vis Inst, Sydney, NSW, Australia
[7] Thornhill Res Inc, Toronto, ON, Canada
[8] Univ Calif Berkeley, Sch Optometry, Berkeley, CA 94720 USA
[9] Toronto Gen Hosp, Dept Anesthesiol, Toronto, ON, Canada
E-mail Addresses: chudson@scimail.uwaterloo.ca

Funding

Funding Agency	Grant Number
Ontario Research Fund (ORF)	

View funding text

Publisher

WILEY-BLACKWELL, 111 RIVER ST, HOBOKEN 07030-5774, NJ USA

Categories / Classification

Research Areas: Neurosciences & Neurology; Physiology
Web of Science Categories: Neurosciences; Physiology

Document Information

Document Type: Article
Language: English
Accession Number: WOS:000369860100008
PubMed ID: 26607393
ISSN: 0022-3751
eISSN: 1469-7793

Journal Information

Impact Factor: Journal Citation Reports®

Other Information

Journal of Physiology

Volume 594, Issue 3, 1 February 2016, Pages 625-640

Relationship between retinal blood flow and arterial oxygen (Article)

Cheng, R.W.[abc], Yusof, F.[ace], Tsui, E.[a], Jong, M.[af], Duffin, J.[bgi], Flanagan, J.G.[adh], Fisher, J.A.[bgi], Hudson, C.[acd]

[a] Department of Ophthalmology and Vision Sciences, Toronto Western Hospital, University Health Network, Toronto, ON, Canada

[b] Department of Physiology, University of Toronto, Toronto, ON, Canada

[c] School of Optometry and Vision Science, University of Waterloo, Waterloo, ON, Canada

View additional affiliations

Abstract

Key points: Vascular reactivity, the response of the vessels to a vasoactive 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 PO2. 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 P ETC O2 of 32-37 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-tidal partial pressure of **oxygen** (P ETC O2) ranging from 40-500 mmHg. **Retinal** vascular response measurements were repeated twice; 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 P ETC O2 of 32-37 mmHg. These vessels have a great vascular range of adjustment, increasing diameter (8.5% arteriolar and 21% total venous area) with hypoxia (40 mmHg P ETC O2; $P < 0.001$) and decreasing diameter (6.9% arteriolar and 23% total venous area) with hyperoxia (500 mmHg P ETC O2; $P < 0.001$) 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. © 2016 The Physiological Society.

ISSN: 00223751 **CODEN:** JPHYA **Source Type:** Journal **Original language:** English

DOI: 10.1113/JP271182 **Document Type:** Article

Publisher: Blackwell Publishing Ltd

References (47)