OXYGEN DELIVERY ENHANCEMENT IN THE MICROCIRCULATION USING PERFLUOROCARBONS DURING EXPERIMENTAL ARTERIAL GAS EMBOLISM

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Introduction

Perfluorocarbon (PFC)

- Acts as a simple gas solvent
- Transport & release of gases is simple passive process
- O_2 dissolved in PFC depends directly on the partial pressure of O_2 (p_aO_2) - Henry's Law
- Does not exhibit the O2 binding properties of hemoglobin
- Particle size (emulsion): 0.1 to 0.5 µm

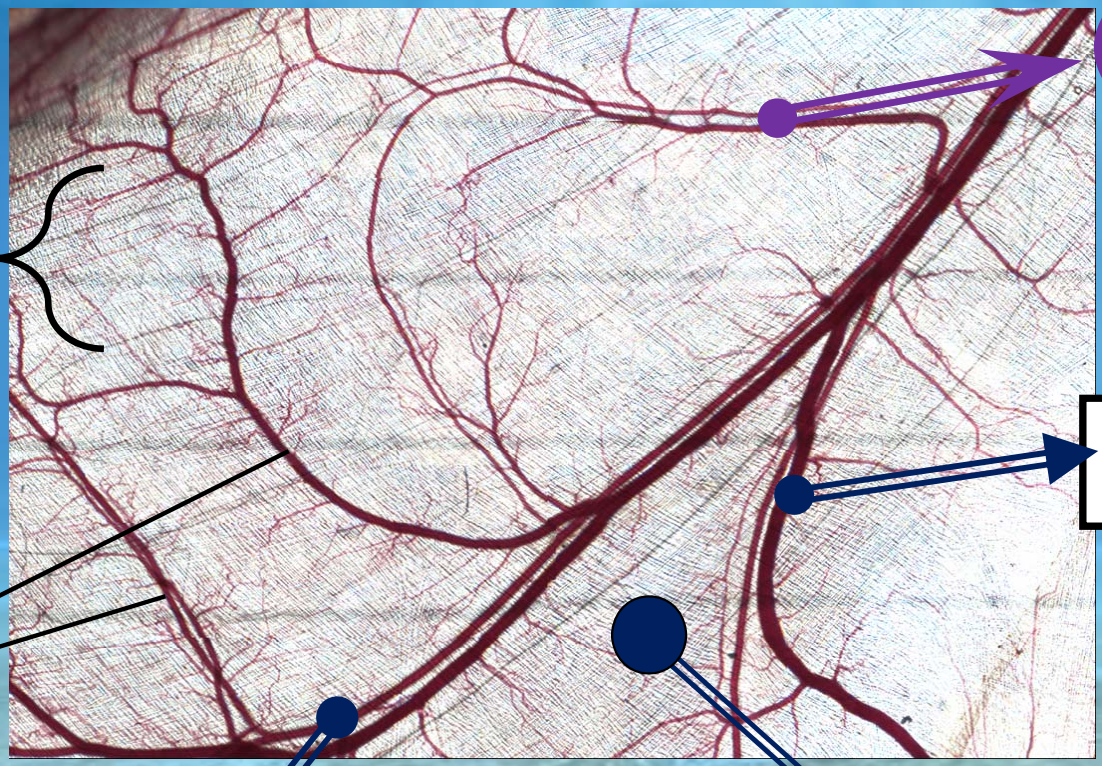
  (*vs* erythrocyte: 7 to 8 µm)

- Half life: 12 – 18 h
- Increases the plasma O_2 content:

  $C_aO_2 = [Hb] \times 1.34 \times SO_2 + 0.0031 \times PO_2$

$C_aO_2 = [Hb] \times 1.34 \times SO_2 + 0.017 \times PO_2 \times FCT$

Introduction – cont.



NO / NO-mediated responses

Functional Capillary Density

Diameter Blood flow
PO_2 SO_2

Glycocalyx
ROS
Leukocyte adhesion

Diameter Blood flow
PO_2 SO_2

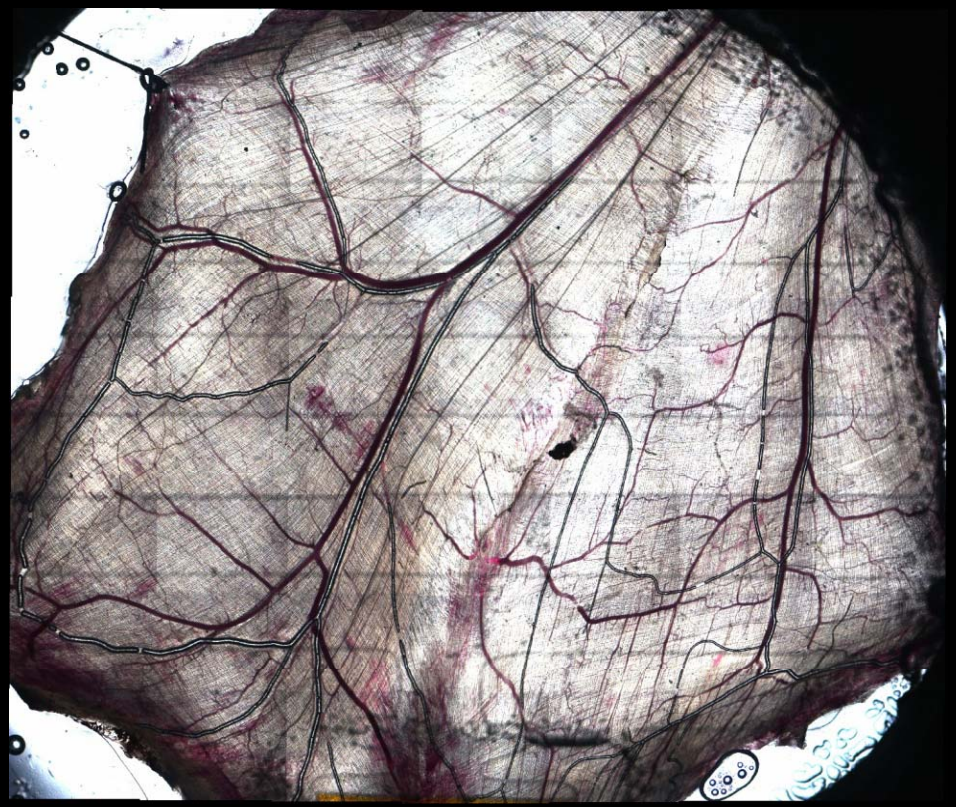
O_2 *delivery*

Tissue PO_2

O_2 *consumption*

Materials & Methods

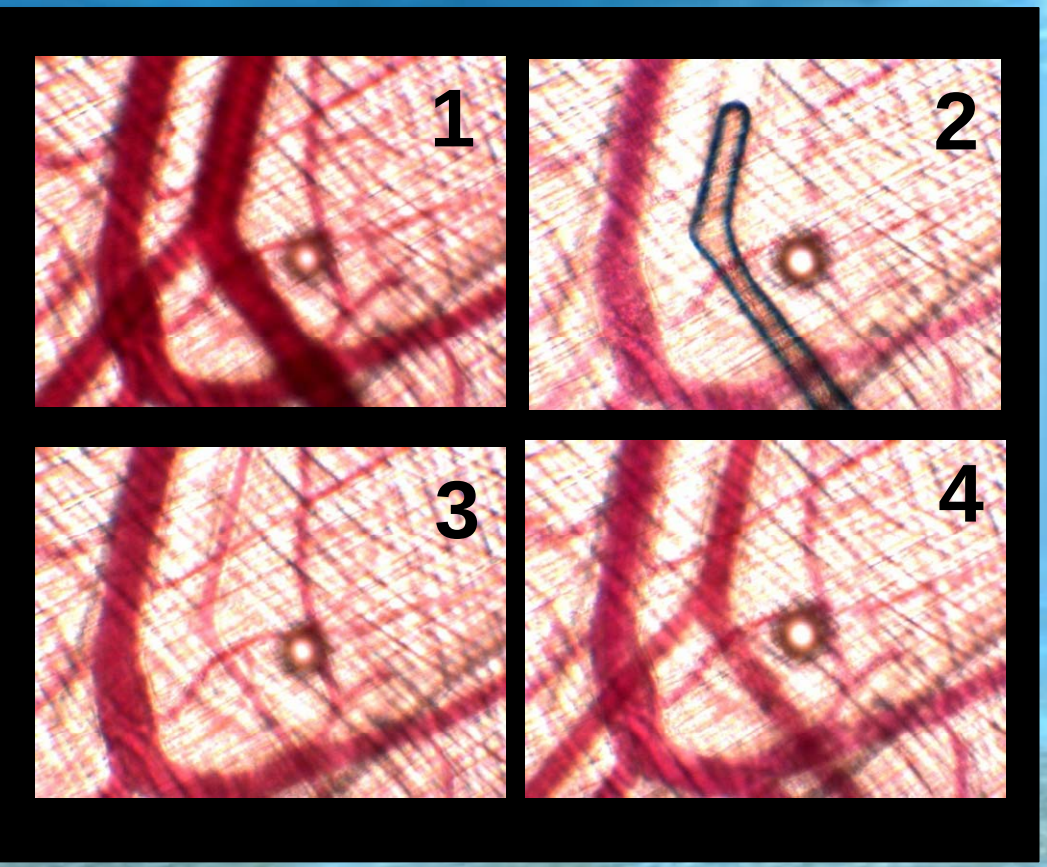
Cremaster microcirculation

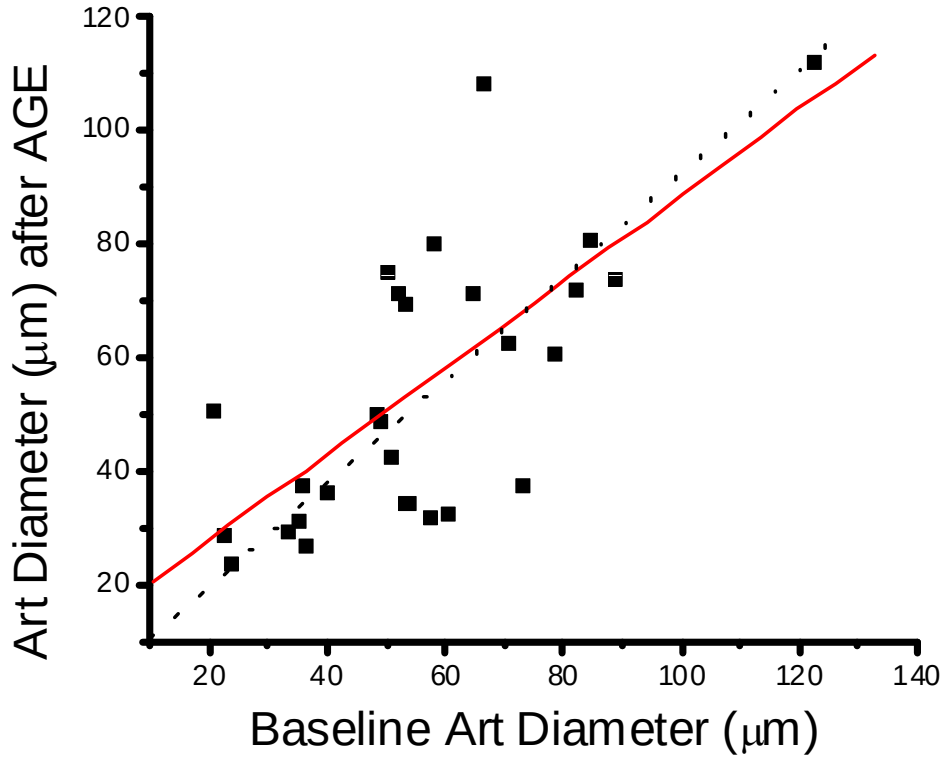


Relevant Research and Results . . . Yesterday, Today, and Tomorrow

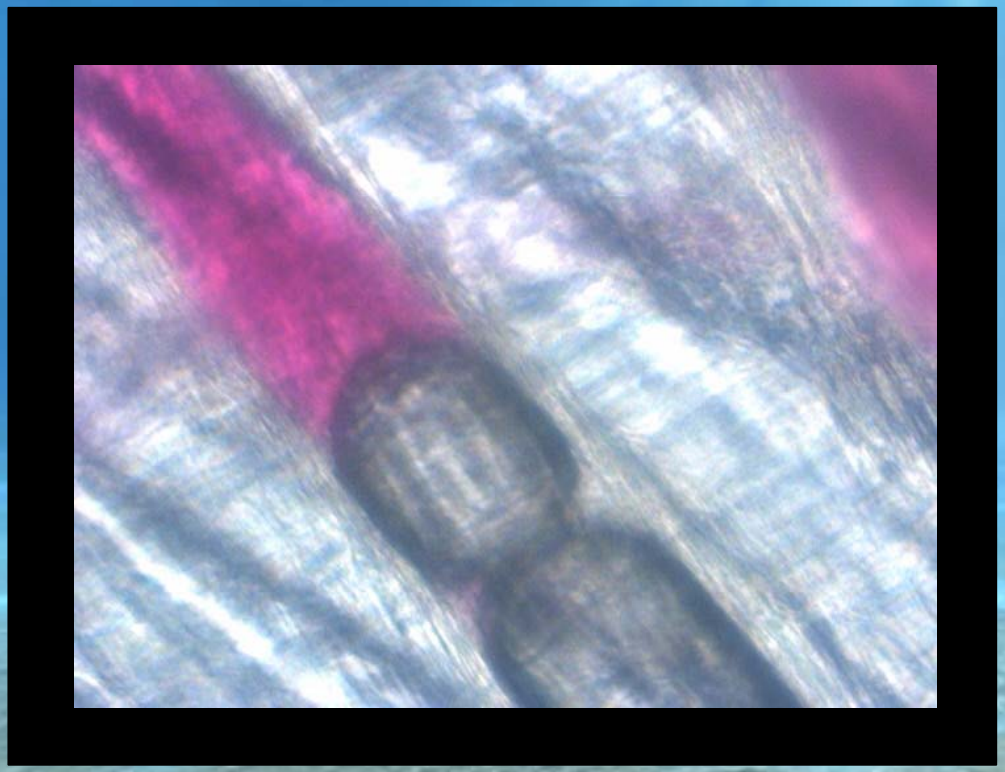
Results

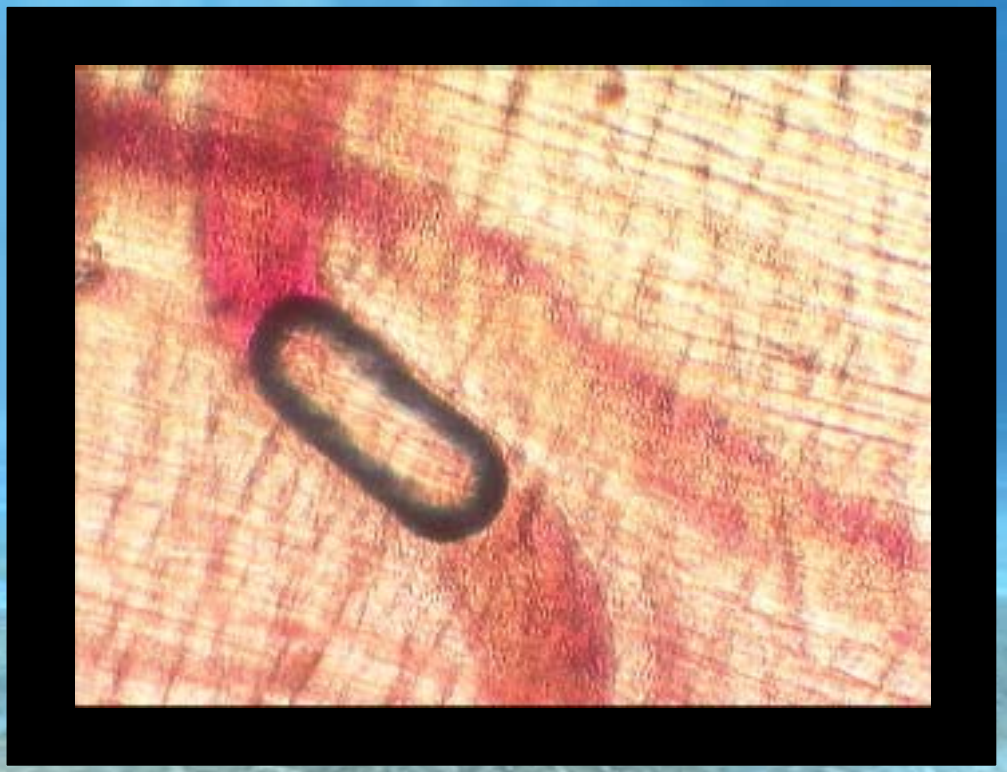
Arteriolar Diameter – Severe AGE protocol





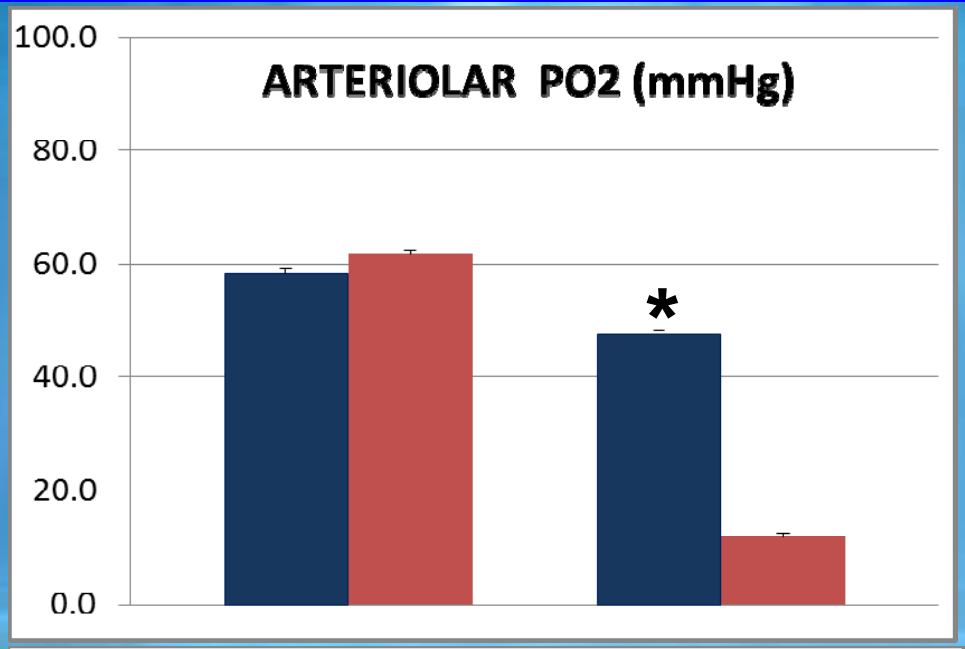
Results

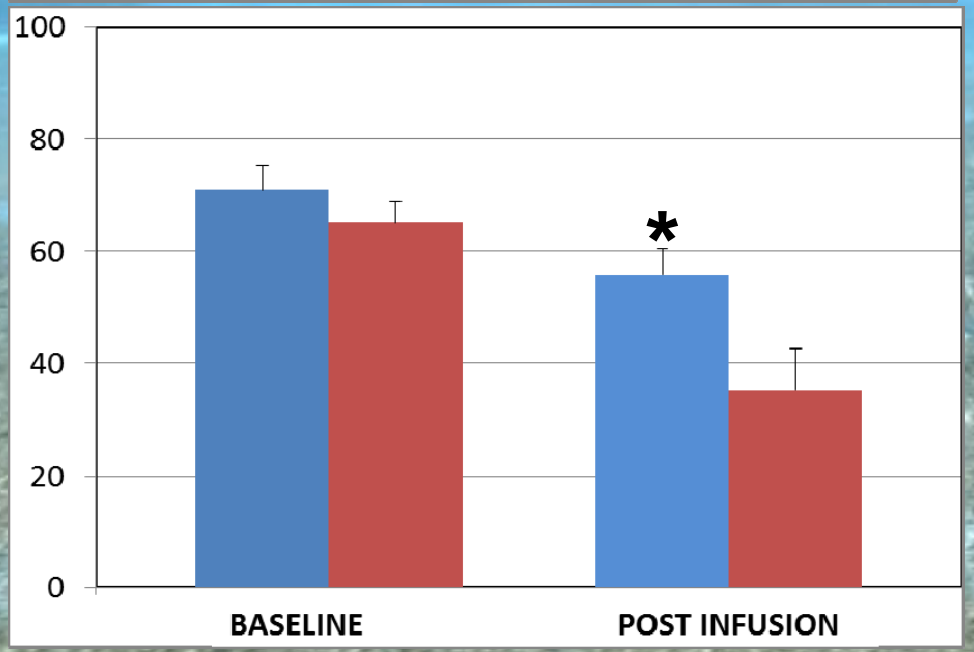




Results

PO_2 measurements – Severe AGE protocol





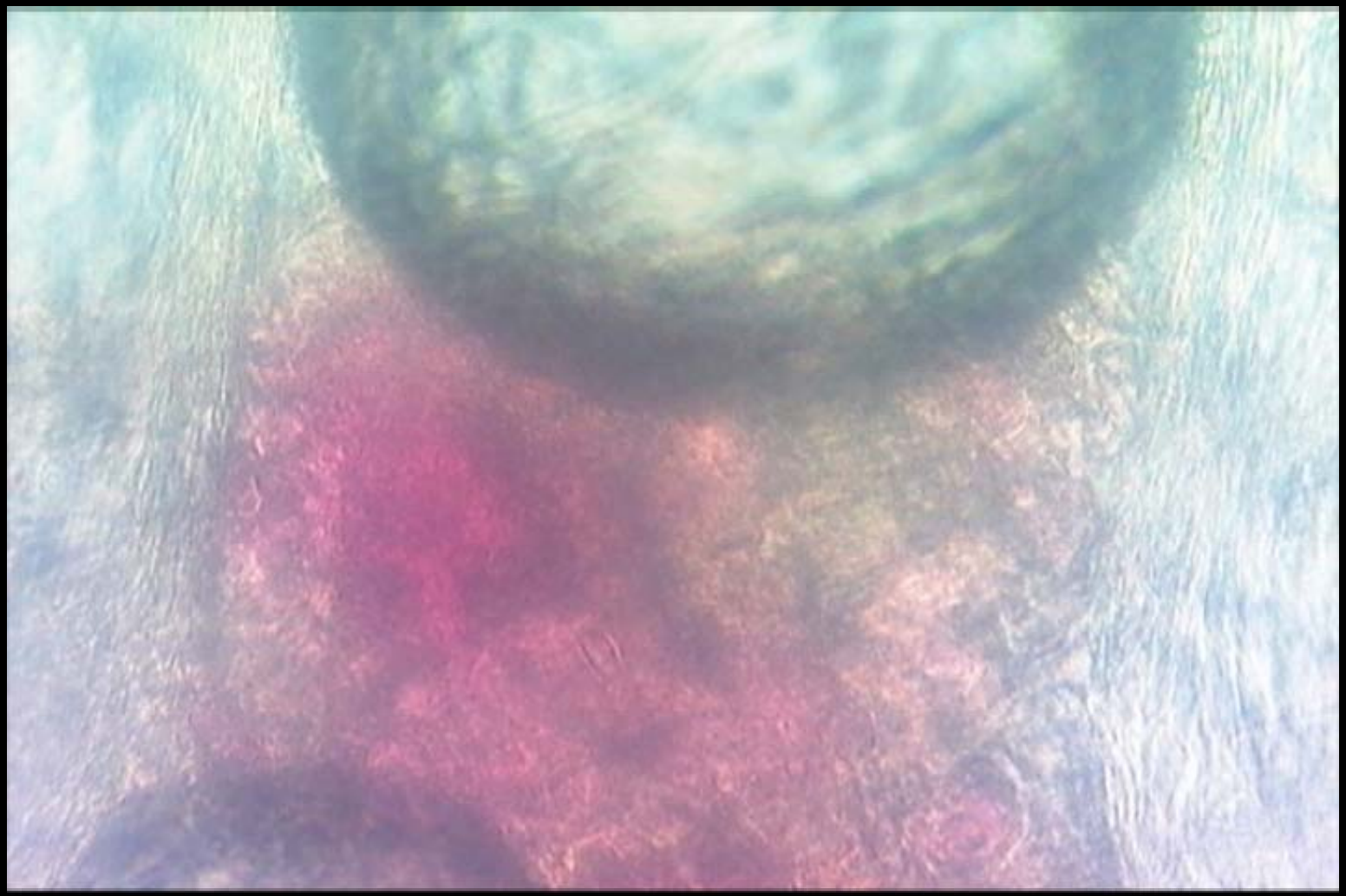
Saline

Oxycyte

PHER-O2

Results

PFC and Air bubble Interaction



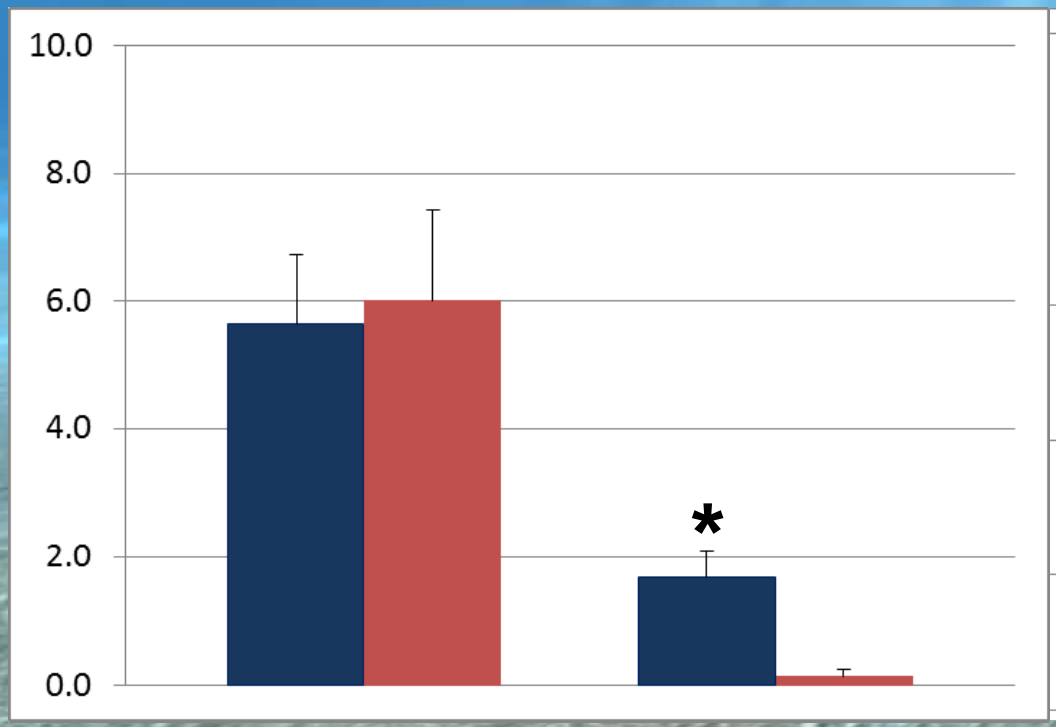
Relevant Research and Results . . . Yesterday, Today, and Tomorrow

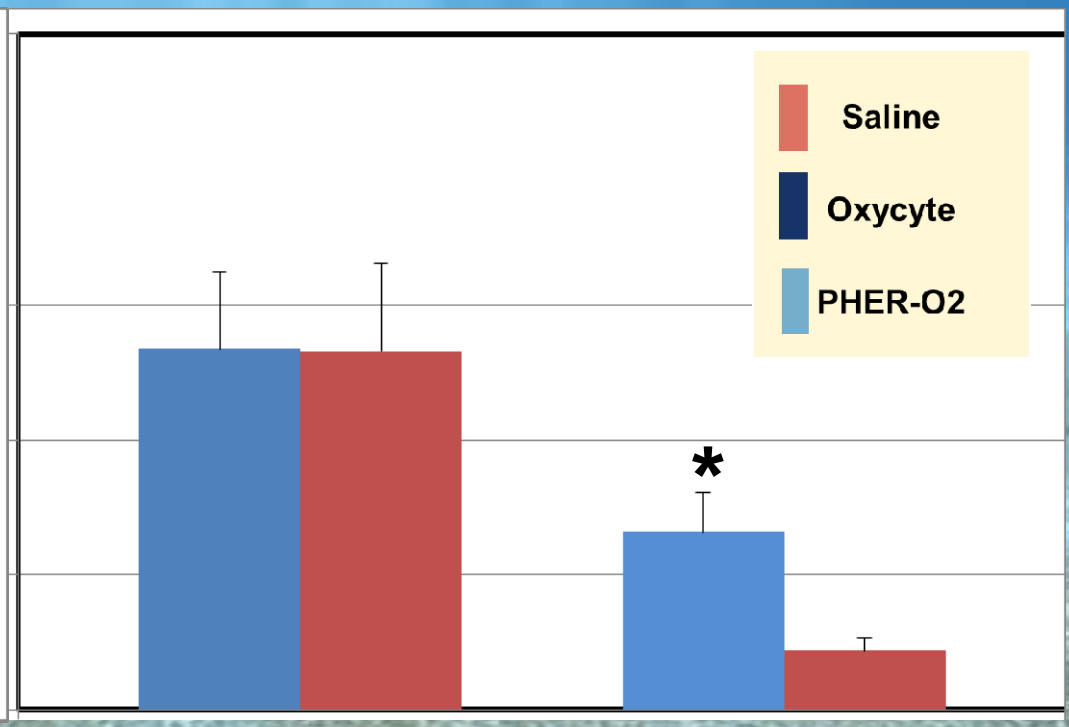
Results

Microvascular DO_2 measurements

$$O2\,ct_{micro} = [Hb] \times 1.34 \times SO2_{micro} + ((1 - Hct - Fct) \times 3.14 \times 10^{-3} \times PO2_{micro}) + (Fct \times 1.7 \times 10^{-2} \times PO2_{micro})$$

$$DO2_{micro} = O2ct_{micro} \times Q_{micro}$$





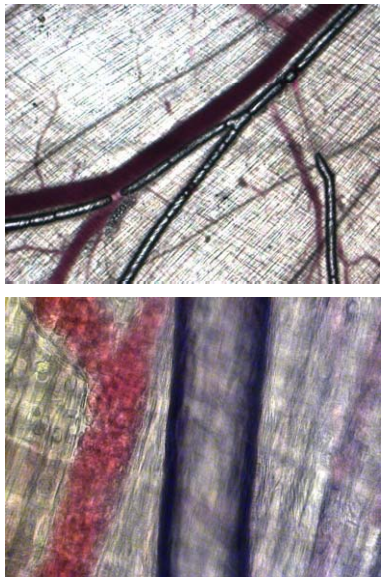
Study of the Microcirculation in Decompression Sickness (DCS), Arterial Gas Embolism (AGE) and Traumatic Brain Injury (TBI) with and without Treatment using a Perfluorocarbon Based Oxygen Therapeutic

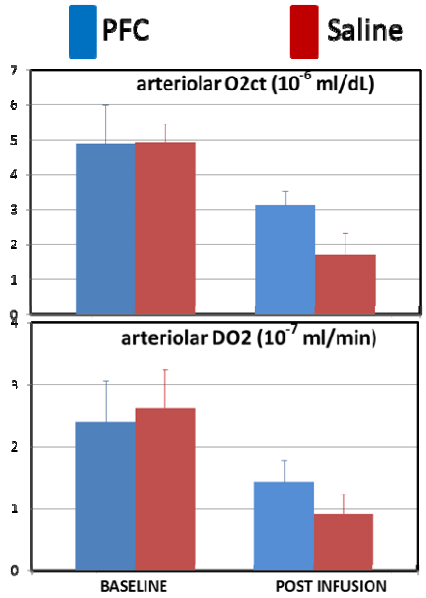
Background: DCS is most commonly encountered when surfacing from a dive or in association with high altitude loss of pressurization. AGE is caused by the entry of gas into the pulmonary veins or directly into the arteries of the systemic circulation. The administration of PFC increases N_2 washout, speeds bubble dissolution and may increase O_2 content and tissue O_2.

Work Effort Benefits: The work effort of this study will provide a basis for the use of perfluorocarbon emulsions as a non-recompression therapy to a severe AGE due to its beneficial effect on bubble clearance associated with changes in oxygen delivery to the tissues in the microcirculation, ultimately preventing cell death and /or impairment of organ function.

Status: ENDING

Arteriolar branches severely embolized with air.





Naval and Scientific Benefits: Provide a better understanding and basis for the use of pefluorocarbon as a non-recompression treatment for AGE. Also, compare the effects of two commercial brands of PFC emulsions in changing oxygen transport at a microvascular and systemic levels.

Deliverables:

☑ Oral and poster presentation in conferences
☑ Evaluation of two different perfluorocarbon emulsions as a treatment for severe AGE: perfluorocarbon 60 % w/v and perfluorodecalin 88% w/v)
☑ Correlation between the degree of embolism, microvascular oxygen transport and cardiorespiratory outcomes.
❑ Final Technical Report / Peer Reviewed Publications

FY11 Accomplishments, Discoveries, & Inventions

- Administration of both PFC emulsions combined with normoxic ventilation improved O2 delivery to tissues after massive AGE
- A lower dose of perfluorodecalin 88% w/v was used to successfully enhanced O_2 delivery.
- Intravenous perfluorodecalin given after cerebral AGE improved motor deficit and cognitive recovery in rat.
- Perfluorodecalin is equally efficacious as other PFCs and provides an alternative supply.

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