New phosphorescence quenching oxygen measurements technique yields unusual tissue and plasma PO₂ distributions

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To the Editor: Wilson et al. (9) report using a novel group of chromophores for measuring oxygen pressure in the interstitial space and blood plasma, proposing that the histogram of PO₂ volume distribution measured in the thigh muscle of mice can be used to 1) describe the partition of tissue and intravascular PO₂ and 2) characterize the difference between intra- and extravascular PO₂ or the vessel wall gradient. Both contentions would appear to be at odds with the results and data presented.

Their histograms (Fig. 2) show intra- and extravascular PO₂ volume fractions of ~10 and 20%, respectively, with PO₂ values of 100–140 Torr. The maximum PO₂ in arterial blood leaving the lungs is ~100 mmHg, and the existence of a longitudinal gradient downstream is a well established feature of PO₂ in the vasculature (8). Even in small animals, it is not clear how the PO₂ of blood in the vasculature or the tissue of the limbs can exceed PO₂ of blood in the lungs. A measurement technique that records such high PO₂ values in the interstitial and the intravascular space raises questions about how the measurements relate to the distribution of PO₂ in the tissue reported by previous investigators.

The review of Tsai et al. (8) on oxygen gradients in the microcirculation shows that the highest PO₂ value recorded in 12 studies of arterioles up to 100 μm using either the microelectrode or the phosphorescence technique was ~80 Torr. Boeghhold and Johnson (1), 1988, recorded in 55-question conclusions regarding a gradient between intravascular PO₂ and extravascular PO₂ of the tissue values were above that level. These large PO₂ values correlated with the visual evidence of agitation... “

Their data show a gradient of 6.1 Torr for isoflurane-anes- thetized animals (free of motion artifacts?) for the same histo- gram PO₂ range. Although it is likely fortuitous, this is the gradient previously reported for hamster capillaries (3).

Assigning a histogram PO₂ level to a microvascular anatomical feature is problematic since the microvascular PO₂ distribution is “U” shaped, many arterioles and venules having similar PO₂ values. The lowest PO₂ values may be due to signals from outside the capillary, measurement of tissue PO₂ near collecting venules or from PO₂ signals from terminal lymphatics, the lowest PO₂ in the tissue (2). Venules contain most of the blood volume in the microcirculation, whose PO₂ is above tissue PO₂ (5). The large intravascular venular blood volume vs. capillary and arteriolar volume should bias PO₂ toward lower values; however, the results of Wilson et al. (9) show that more than half of intravascular volume has PO₂ >50 Torr.

In summary, this new technique for measuring tissue and intravascular PO₂ appears to be flawed since it reports tissue and intravascular PO₂ measurements (100–140 Torr) not compatible with the physics of oxygen distribution in a mammal. Very high PO₂ values in the distribution indicate the presence of effects that probably influence the whole data set. In the muscle microcirculation there is no evidence of PO₂ values greater than ~60–70 mmHg, and, as reported by previous
investigators, most values are much lower. A careful reevaluation of the in vivo application of this method would appear to be in order.

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REFERENCES