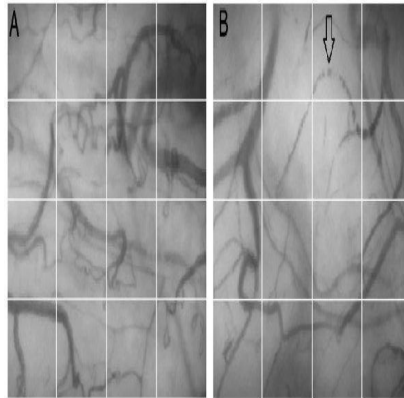




Study: Hyperoxia Alters Microcirculation in Healthy Volunteers



Hyperoxia may induce vasoconstriction and alter endothelial function. However, recent data suggest a potential therapeutic role of normobaric hyperoxia (NH) in sepsis and cerebral ischaemia.

In this study, researchers evaluated the effects of NH on the microcirculation in 40 healthy adult volunteers using side-stream dark field (SDF) video-microscopy on the sublingual area and near-infrared spectroscopy (NIRS) on the thenar eminence. They found that NH altered the microcirculation in healthy subjects, decreasing capillary perfusion and muscle oxygen consumption and increasing the heterogeneity of the perfusion.

Results of the study are published in *Microvascular Research*.

Methodology

The subjects (40 healthy adult volunteers) were placed in a quiet and temperature-controlled room within the department of intensive care. They rested comfortably seated for 15 minutes before each experiment. At least one vascular occlusion test (VOT) was performed in the 15 minutes before the initiation of measurements to familiarise the volunteers with the NIRS technology.

In a first group of 18 volunteers, measurements were taken every 30 minutes: at baseline in air, during NH (close to 100 percent oxygen via a non-rebreathing mask) and during recovery in air. In a second group of 22 volunteers, NIRS measurements were taken in NH or ambient air on two separate days to prevent any potential influence of repeated NIRS measurements.

The researchers evaluated non-invasively the heart rate (HR), respiratory rate (RR) and haemoglobin saturation by pulse oximetry (SpO₂) with a Siemens SC 9000 monitor. Non-invasive measurements of mean arterial pressure (MAP) were obtained in the opposite arm to that used for the NIRS measurements, at each study time point.

Microcirculation video-microscopy recordings were performed using an SDF imaging device (Microvision Medical BV) with a probe on the sublingual area. At each time point, five different sites were evaluated and videos of at least 12 seconds were recorded.

Tissue oxygen saturation (StO₂) was evaluated using a near-infrared spectrometer (InSpectra 850 model, Hutchinson Technology), with a 15 mm-probe attached to the thenar eminence. InSpectra Software Analyzer version 3.0. (Hutchinson Technology) was used to measure the baseline, minimal and maximal StO₂ (StO₂

base, StO₂ min and StO₂ max, respectively) and total haemoglobin index (THI base, THI min and THI max, respectively).

NIRS measurements were obtained at each study time point, but SDF measurements and venous blood samplings were obtained only in the first 10 volunteers, because the results were already significantly different in these participants.

Results and Discussion

NH significantly decreased the proportion of perfused vessels (PPV) from 92 percent to 66 percent, perfused vessel density (PVD) from 11.0 to 7.3 vessels/mm, perfused small vessel density (PSVD) from 9.0 to 5.8 vessels/mm and microvascular flow index (MFI) from 2.8 to 2.0, and increased PPV heterogeneity from 7.5 percent to 30.4 percent. Thirty minutes after return to air, PPV, PVD, PSVD and MFI remained partially altered.

During NH, NIRS descending slope and NIRS muscle oxygen consumption (VO₂) decreased from 8.5 to 7.9 percent/second and 127 to 103 units, respectively, in the first group and from 10.7 to 9.4 percent/second and 150 to 115 units in the second group.

These findings in human volunteers are concordant with previous animal data that specifically reported data on the density of microcirculatory perfusion (Kamler et al., 2004; Lindbom and Arfors, 1985; Tsai et al., 2003). Using in vivo video microscopy, the density of perfused capillaries was shown to decrease under NH to around 70 percent of baseline value in the muscle of rabbits (Lindbom and Arfors, 1985) or in the dorsal microcirculation of hamsters (Kamler et al., 2004; Tsai et al., 2003).

Whether reduced capillary perfusion was the consequence or the cause of the decreased VO₂, is a difficult question. NH may directly diminish cellular metabolism and VO₂, so that the microcirculatory changes could represent just an adaptive phenomenon; alternatively, oxygen could impair the microcirculation and endothelial functioning, with subsequent metabolic alterations.

The authors also observed a marked increase in the heterogeneity of capillary perfusion, a condition that has been typically associated with the distributive alterations observed in sepsis and associated with alterations in tissue perfusion and markers of severity in critically ill patients (Edule et al., 2012; Trzeciak et al., 2007).

While this study was designed to evaluate the effects of NH on the microcirculation, it was limited in its ability to detect the physiopathological pathways involved in the appearance of these changes. To definitively determine whether these changes are adaptive or not, additional research in the field is necessary.

Conclusions

NH induced a decrease in capillary perfusion and in muscle VO₂, and increased microcirculatory perfusion heterogeneity. NH did not alter the reactive hyperaemia after an ischaemic challenge. These microcirculatory variables have been independently associated with patient outcomes, including mortality (Sakr et al., 2004), so they should be further evaluated during the use of hyperoxia as a therapeutic strategy.

Image Credit: Microvascular Research

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