Respiration

TITLE: THE STIMULUS (P_{SO2}) FOR HYPOXIC PULMONARY VASOCONSTRICTION (HPV) IN DOGS

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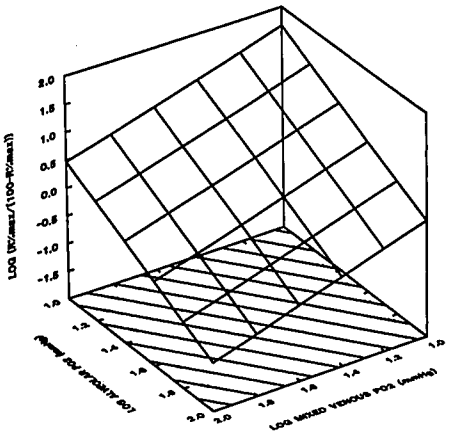
Previous work has established[1] that both alveolar (P_{AO2}) and mixed venous ($P_{\bar{v}o2}$) oxygen tension contribute to HPV and in rats[2] is described by $P_{SO2} = (P_{AO2})^{0.62} * (P_{\bar{v}o2})^{0.38}$, where P_{SO2} is the effective oxygen tension in the vascular smooth muscle. This relationship has now been explored in dogs.

Methods. Eleven adult female dogs were anesthetized with pentobarbital. The lungs were ventilated independently with a dual piston pump via a double lumen endobronchial tube. A standard pump/oxygenator circuit was provided to establish flow to the isolated left pulmonary artery with blood drawn from the right atrium. In this manner the blood flow and the alveolar and "mixed venous" oxygen tensions to the left lung were controlled. The HPV response was measured as changes of pulmonary artery pressure. In Group 1 (n=5) the P_{AO2} and $P_{\bar{v}o2}$ were simultaneously set at approximately 700, 100, 65, 45, 25 and 0 mmHg. In Group 2 (n = 6) the minimum and maximum responses were observed with both P_{AO2} and $P_{\bar{v}o2}$ set at 700 and 0 mmHg but thereafter the P_{AO2} and $P_{\bar{v}o2}$ were dissimilar with seven combinations chosen from 100, 70, 40, and 0 mmHg.

Results. The HPV response is expressed as a percent of the maximum response (R%max) observed with zero oxygen to both P_{AO2} and $P_{\bar{v}o2}$. The linearized response surface derived from the 67 data points is shown in the figure. The stimulus for HPV is described by $P_{SO2} = (P_{AO2})^{0.57} * (P_{\bar{v}o2})^{0.43}$



Conclusion. The data support two conclusions: 1) the HPV response continues to increase as P_{SO2} decreases and does not plateau at 30 mmHg. 2) The stimulus for HPV for all animal species is probably approximated by $P_{SO2} = (P_{AO2})^{0.6} * (P_{\bar{v}o2})^{0.4}$.

This study supported by NIH GM 29628.

References: 1. Hyman et al, J Appl Physiol 51:1009, 1981. 2. Marshall B et al. J Appl Physiol 55: 711, 1983.

TITLE: THE INFLUENCE OF VASCULAR PRESSURE ON HYPOXIC PULMONARY VASOCONSTRICTION

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When the hydrostatic pressure is increased in the pulmonary circulation the hypoxic pulmonary vasoconstrictor (HPV) response is altered[1,2]. This study has examined the physiological basis for this effect.

Methods. In isolated, perfused and ventilated rat lungs[3] the HPV was established by repeated ventilation for 6 minutes with hypoxic gas (3% O_2, 5% CO_2,) alternating with normoxic gas (21% O_2, 5% CO_2). The HPV response was measured in group 1 when the pulmonary flow was increased while LAP was zero and in group 2 at two different flows with the LAP at 0, 10 and 20 cm H_2O. In addition, utilizing a mathematical model of the pulmonary circulation[4], the specific biodynamic properties that were responsible for the observed effects were identified.

Results. Figure A compares the mean data points (filled circles) and the results of the computer analysis (solid line) for group 1 and Figure B the mean data points (symbols) and model (solid lines) analysis for group 2. Both demonstrate a bimodal effect of pressure on the HPV response. The initial increase of response as PAP increases is due to the greater compliance of the normoxic lung. However, as the vessels enlarge each increment has less effect and furthermore there is a diameter limit for each pulmonary vessel beyond which it becomes stiffer. The vessels in normoxic lung reach their limiting diameter at lower pressures than constricted vessels in the hypoxic lung and the difference in conductance between the normoxic and hypoxic lungs is progressively reduced. This sequence is enhanced as the LAP is increased.

Conclusion. The HPV response is bimodal with pressure due to the differences in vascular compliance between relaxed and constricted vessels together with the limited distensibility of each vessel.

This work supported in part by NIH GM29628.

References. 1. Benumof JL, et al., J. Appl Physiol 38:846, 1975. 2. Cheney FW et al., J. Appl Physiol 62:776, 1987. 3. Marshall C. 4. Marshall BE: J. Appl. Physiol 64:68, 1988.