Title : PEEP INDUCED P_{paw}-P_{1a} GRADIENT: FUNCTION OF ABSOLUTE P_{1a}

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Introduction. Pulmonary arterial (PA) wedge pressure (P_{paw}) is considered an accurate reflection of left atrial (LA) pressure (P_{1a}) provided there is a continuous column of fluid (Zone III, $P_{pa} > P_{1a} > P_A$) between the PA catheter tip and the LA. Positive end-expiratory pressure (PEEP) can intermittently collapse (Zone II, $P_{pa} > P_A > P_{1a}$) and perhaps continuously collapse (Zone I, $P_A > P_{pa} > P_{1a}$) this column of fluid depending on the relative magnitude of P_{1a}, P_{pa} and PEEP and the vertical hydrostatic gradient between the PA catheter tip and the LA. It has previously been shown that with a PA catheter tip positioned vertically above the LA and with a normal P_{1a} the application of PEEP 15 torr caused a significant gradient between P_{paw} and P_{1a}. In theory, but not proven, increasing P_{1a} should prevent PEEP from causing a gradient between P_{paw} and P_{1a}. The purpose of this experiment was to systematically test this hypothesis.

Methods. Mongrel dogs were anesthetized with pentobarbital 25 mg/kg i.v., tracheally intubated, paralyzed with pancuronium 0.1 ml/kg i.v. and mechanically ventilated with 100% O_2, tidal volume 15 ml/kg and ventilatory rate so that end-tidal CO_2=5%. In the right lateral decubitus position and following a left thoracotomy, cardiac output (Q_t) was continuously measured electromagnetically, and P_{1a} was measured with a catheter placed via the LA appendage. A transcutaneously passed Swan-Ganz catheter was guided from within the chest to a location above the LA and was used to measure P_{pa} and P_{paw}. All vascular pressures were always recorded at end expiration. Two methods were used to increase P_{1a}: (1) In 6 dogs a second catheter with an inflatable balloon at the tip was inserted into the LA, and P_{1a} was increased by LA balloon inflation; (2) in 6 dogs P_{1a} was increased by dextran infusion. The experimental sequence consisted of measuring P_{paw} and P_{1a} at PEEP 0, 5, 10 and 15 torr during controlled mechanical ventilation when $P_{1a} \simeq 6$ torr and when $P_{1a} \simeq 25$ torr. The results are expressed as mean ±SE and were analyzed by paired t analysis with $p<0.01$ considered significant.

Results. Table 1 shows that LA balloon inflation increased P_{1a} but decreased Q_t, whereas Table 2 shows that dextran infusion increased both P_{1a} and Q_t. In both groups, at normal P_{1a}, the gradient $P_{(paw-1a)}$ was increased significantly at PEEP 10 and 15 torr. In both groups, at high P_{1a}, $P_{(paw-1a)}$ did not change significantly at any PEEP level except for a 2 torr gradient at PEEP 15 torr in the dextran group.

Table 1: P_{paw} and P_{1a} as a function of LA balloon inflation ($\uparrow P_{1a}$)

	Control			LA Balloon		
PEEP torr	P_{1a} torr	P_{paw} torr	Q_t L/min	P_{1a} torr	P_{paw} torr	Q_t L/min
0	6±0.7	8±1.0	3.0±0.4	28±0.8	28±0.7	1.6±0.2
5	7±0.8	9±1.0*	2.9±0.5	25±2.2	25±1.8	1.7±0.2
10	8±0.9	12±1.2*	2.4±0.4†	25±1.5	26±1.2	1.5±0.2
15	9±0.6	19±1.4*	1.4±0.2†	26±1.1	26±0.9	1.2±0.1

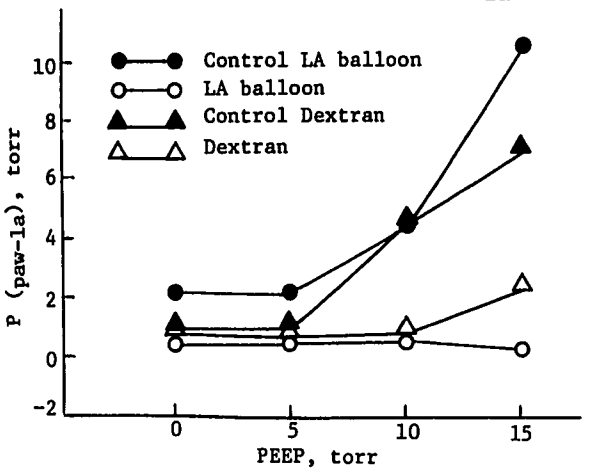
* $p<0.01$ significant from P_{1a}
† $p<0.01$ significant from previous PEEP

Table 2: P_{paw} and P_{1a} as a function of dextran infusion ($\uparrow P_{1a}$)

	Control			Dextran		
PEEP torr	P_{1a} torr	P_{paw} torr	Q_t L/min	P_{1a} torr	P_{paw} torr	Q_t L/min
0	8±1.8	9±1.8	1.2±0.1	21±1.8	22±2.0	3.2±0.6
5	9±1.6	10±1.1	1.1±0.1	21±1.3	21±1.4	3.3±0.7
10	9±1.3	14±0.2*	1.1±0.1	19±1.3	19±1.3	2.8±0.6
15	10±1.3	17±0.1*	0.6±0.1	18±1.6	20±1.6*	2.2±0.4

* $p<0.01$ significant from P_{1a}

The graph demonstrates that with increasing PEEP levels a significant difference between P_{paw} and P_{1a} occur only at normal P_{1a}.



Discussion. These results are important for two reasons. First they indicate that when P_{1a} is increased, the lung remains in Zone III despite an increase in PEEP from 0 to 15, torr and therefore the P_{paw} remains an accurate reflection of P_{1a}. Second the effects of several of the conditions known to increase the clinical confidence in the P_{paw} as an accurate reflection of P_{1a} may be additive. These clinical conditions include noncompliant lungs, spontaneous ventilation, PA catheter position below the LA and now presently demonstrated increased P_{1a}.