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Title : ACCURATE MEASUREMENT OF INTRAPLEURAL PRESSURE

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Introduction. A simple, safe, and accurate method for measuring intrapleural pressure (P_{pl}) of certain critically ill patients is highly desirable. The clinician's ability to accurately interpret measured intravascular pressures may be impaired by significant alteration that may occur in the P_{pl} of patients receiving mechanical ventilatory support, especially with positive end-expiratory pressure. In addition, measurement of P_{pl} is necessary to accurately calculate lung compliance. Previously, we described a technically simple and safe method for directly measuring P_{pl};[1] however, the accuracy of that method has been questioned.[2] Therefore, we sought to determine the accuracy with which a known change in P_{pl} would be reflected in direct measurements, with a saline filled catheter, of P_{pl}.

Methods. Seven dogs were anesthetized with incremental doses of sodium pentobarbital to a total of 25 mg/kg. Their tracheas were intubated with cuffed, endotracheal tubes with an outside diameter of 10 mm. The cuff was inflated and positive airway pressure was applied to ensure a tight seal. By using the method previously described,[1] a fluid-filled, 17-ga Teflon® catheter was inserted into the right-lateral intrapleural space through a 12-ga over-the-needle polypropylene introducer. The catheter was connected to a fluid-filled, three-way stopcock to facilitate irrigation and aspiration. Inability to aspirate air from the intrapleural catheter ensured absence of pneumothorax. A 5-Fr microtransducer-tipped catheter (Millar;Houston, TX) precalibrated with a water manometer was inserted into the stopcock to measure P_{pl}. Airway pressure (P_{aw}) was measured at the endotracheal tube with wide-bore, high-pressure tubing coupled to a similarly calibrated transducer (P23Ia; Gould-Statham; Hato Rey, P.R.) Transduced pressures were amplified and recorded with a fiberoptic recording system (Honeywell, Inc.; Minneapolis, MN) at a recording speed of 2.5 cm/sec. Animals were allowed to breathe spontaneously and pressures were continuously recorded. At a point in time when respiration was stable and pressure between breaths was consistent, the endotracheal tube was tightly clamped at end-exhalation. With the airway totally occluded, P_{aw} and P_{pl} then were recorded during the next inspiratory effort. Simultaneous changes in P_{aw} and P_{pl} were measured at 50% and 100% of time elapsed from the onset of inspiration to peak inspiration and referenced to the values obtained at end-expiration immediately before each maneuver. The endotracheal tube was unclamped until a stable respiratory pattern returned once again. This sequence was repeated six times for each animal to ensure reproducible measurements. Changes in P_{pl} and in P_{aw} were subjected to linear regression analysis to determine the degree and significance of correlation.

Results. As animals attempted to inhale against the obstructed airway, P_{pl} decreased significantly as did P_{aw}. The following equation describes the relationship between change in P_{pl} (ΔP_{pl}) and change in P_{aw} (ΔP_{aw}):

$$\Delta P_{pl} = 1.09 \times \Delta P_{aw} - 0.33.$$

The correlation between the changes was highly significant ($r = 0.96$; $p < 0.0001$).

Discussion. Alteration in P_{pl} may be reflected by change in intrathoracic intravascular pressures. However, even though an increase in P_{pl} may increase central venous and pulmonary artery occluded pressures, the transmural pressures actually may decrease.[3] Therefore, accurate assessment of cardiac filling pressures may require the measurement of P_{pl} of some patients. When measured during an inspiratory effort against an occluded airway, P_{pl} and P_{aw} should decrease equally. Change in lung volume requires a change in transpulmonary pressure, which is the gradient between P_{pl} and P_{aw}. Since there can be essentially no change in lung volume when the airway is occluded, there should be no change in the P_{aw}-P_{pl} gradient. The slope of the regression line was nearly unity and the intercept was nearly 0, which indicates identical change in P_{pl} and P_{aw} during inspiration against an occluded airway. These results indicate that changes in P_{pl} can be accurately and reliably measured by using a fluid-filled intrapleural catheter. These measurements may be helpful in assessing vascular filling pressure and in calculating lung compliance of some critically ill patients.

References

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