Lung U/S Correlates to Chest X-ray and Other Changes in a Swine Model of ARDS/Septic Shock

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Abstract:
RATIONALE: Acute respiratory distress syndrome (ARDS) is a severe form of acute lung injury that contributes to 10-15% of all critical care admissions, causing significant morbidity and mortality. Despite modern advances in medicine, and despite years of clinical trials assessing therapeutics through the NHLBI ARDS Network (ARDSnet), mortality after ARDS diagnosis stubbornly remains at 40%. Survivors of ARDS often suffer from poor lung function and neurocognitive dysfunction for a prolonged period of time.[2] Early diagnosis is critical for improving ARDS prognosis by employing therapeutic measures, thus an easy to use and highly accessible diagnostic method is needed to aid in this goal. For this reason, we developed a Yorkshire swine model survivable ARDS, using a triple hit model of bacterial sepsis, aspiration and ventilator-induced lung injury (VILI). METHODS: Sedated and intubated swine (n=3) were given a 1hr intravenous infusion of allogenic cecal slurry (8 $x10^7$ CFU) from a donor pig, followed by autologous gastric fluid aspirate administration into the right lower (10ml) and right middle (10ml) lobes via bronchoscopy. VILI induction followed with tidal volumes of >15ml/kg (to achieve PIP of 35cm H_2O), until lung compliance dropped below 30ml/cmH_2O, followed by low PEEP lung protective ventilation. Chest X-ray (CXR) and lung ultrasound (LUS) were performed and scored every 6 hours, and clinical signs/pulmonary function parameters were monitored continuously for 48 hrs. RESULTS: All animals survived to 48hrs. LUS scores worsened immediately in all swine within the right posterior and right lateral lobes after gastric fluid administration, then improving slightly over time (coalescent B-lines). All other lung lobes (left lower, left and right upper, etc) had a delayed worsening within the first 8 hours, followed by further worsening throughout the study. P/F ratio decreased to <200 with a drop of lung compliance to <25cm H2O. LUS detected lung abnormalities 4hrs prior to P/F and CXR changes. CONCLUSIONS: ARDS development in this triple-hit swine model was easily tracked with bedside LUS, and LUS was able to detect worsening of acute lung injury 4hrs prior to CXR, P/F ratio, and pulmonary mechanics changes.