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Elevated airway liquid volumes at birth: a potential cause of transient tachypnea of the newborn

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Before birth the fetal lungs are filled with liquid, which must be cleared at birth to allow entry of air and onset of gas exchange. The rate of preterm birth and non-labour caesarean delivery has substantially increased, which delays lung liquid clearance and increases the risk of neonatal respiratory complications. Retention of liquid in airways and/or lung tissue is thought to underpin the respiratory morbidity associated with transient tachypnea of the newborn (TTN). TTN results in rapid and laboured breathing immediately after birth or in the hours following delivery, that often requires respiratory support. We examined the effects of elevated airway liquid volumes on respiratory function in the immediate newborn period. Pregnant New Zealand white rabbits underwent caesarian surgery and fetal rabbits (kittens) were delivered at 30 days of gestation (term, ~32 days). Following delivery, kittens were surgically intubated, and either had lung liquid drained to mimic the natural clearance at birth (Control, n=7) or had liquid added to the lungs (30ml/kg; 0.9% sodium chloride) to mimic delayed liquid clearance (TTN, n=7). Kittens were positioned inside a plethysmograph and were mechanically ventilated. Phase contrast X-ray images were obtained (24keV; 10Hz framerate; 20ms exposures; 2m propagation distance; at the SPring-8 synchrotron in Japan), and imaging analysis was undertaken to determine regional lung gas volumes, airway dimensions and chest and lung shape and size. Data were analysed using a two-way repeated measures ANOVA with Sidak's multiple comparisons test ($P < 0.05$). Following ventilation onset, TTN kittens exhibited differences in the temporal and spatial pattern of lung aeration. TTN kittens required a greater time to achieve lung aeration and exhibited regional differences in aeration pattern. Delayed lung liquid clearance in the TTN group resulted in differences in the size of alveoli and uniformity of lung aeration. The average airway size was greater in TTN kittens, particularly in the upper lung quadrants. The excess liquid in the TTN group resulted in an increase in the radius of the diaphragm, increased lung height and total chest area. We have provided evidence for adverse effects of delayed lung liquid clearance on lung structure and function in the immediate neonatal period. This reduced ability of the lung to aerate efficiently provides evidence for increased respiratory morbidity in these neonates following birth. Overall, tailoring respiratory management strategies may lead to improved outcomes for these babies in clinical practice.

Keywords or phrases (comma separated)

lung liquid, lung aeration, neonatal complications, phase contrast X-ray

Are you a student?

No

Do you wish to take part in the Student Poster Slam?

No

Are you an ECR? (<5 yrs since PhD/Masters)

Yes

What is your gender?

Female

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