Fixed-Duration versus EIT-determined Volume-Response Defined Sustained Inflation in Preterm Lambs

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Abstract: We compared a standard fixed duration Sustained Inflation (SI) during resuscitation at birth in preterm lambs with two SI guided by real-time volumetric EIT imaging, lasting respectively until volume plateau and until 30s beyond plateau. Global and local end expiratory volume (EEV), lung mechanics and gas exchange were measured. Both the volumetric EIT guided approaches were feasible and resulted in better relative lung aeration.

1 Introduction

Sustained Inflation (SI) is gaining increasing interest as a method of lung recruitment at birth [1]. A SI consists of applying a continuous elevated airway pressure to enhance lung liquid clearance and achieve functional residual capacity [2]. However the best way to deliver SI still remains to be elucidated [3]. Current SI strategies use a fixed duration and pressure, irrespective of the individual mechanical properties of the lung. The time constant of the lung is highly variable and unpredictable at birth. We aimed to investigate a new SI strategy tailored to the recipient's individual needs, in which duration was determined by the volumetric response at birth. Secondly, we wished to determine if a long SI would be harmful for the preterm lung.

2 Methods

127±1 day preterm lambs were instrumented, intubated and EIT electrodes applied before birth. Lambs were randomly assigned to one of following strategies at birth (n=11-13/group):

1. Control (PEEP group): positive pressure ventilation (PEEP 8 cmH_2O, PIP_{max} 40 cmH_2O)
2. Fixed duration SI (SI_{30}): 40 cmH_2O for 30s
3. EIT guided SI (SI_{EIT}): SI at 40 cmH_2O continued until no further visible gain in global lung volume (V_L) on EIT monitor (Thorascan, Carefusion, Germany).
4. SI_{long}: as for SI_{EIT} but continued for 30s after V_L stability was achieved in the global EIT-signal.

Thereafter, lambs were ventilated in a volume guarantee modality with 7 ml/kg tidal volume for 60 min.

Pressure, SpO_2, lung mechanics (including Forced Oscillation Technique; FOT), global and regional EEV and ventilation changes by EIT were recorded from birth, along with arterial blood gases. At 60 min lambs were euthanized and tissue taken for injury analysis. Differences between groups were tested by two-way ANOVA and Bonferroni *post hoc* test.

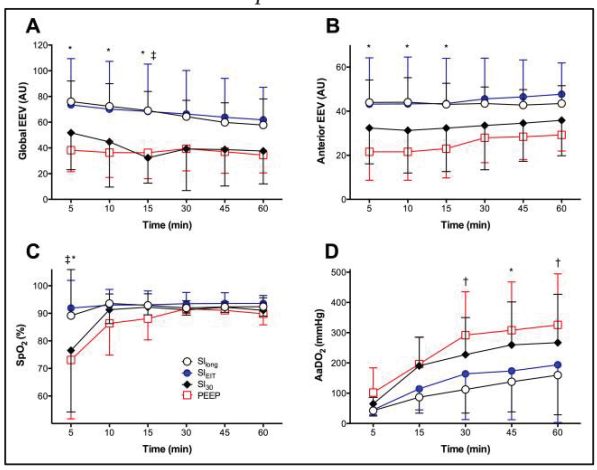

Figure 1: A. Global EEV, **B.** Anterior hemithorax EEV, **C.** Oxygen saturation (SpO_2) and **D.** Alveolar-arterial oxygen difference ($AaDO_2$). All data mean±SD. *PEEP vs SI_{long} & SI_{EIT} $p<0.05$; †PEEP vs SI_{long} $p<0.05$; ‡SI_{30} vs SI_{long} & SI_{EIT} $p<0.05$; §SI_{30} vs SI_{long} $p<0.05$.

3 Results

Both SI_{EIT} and SI_{long} resulted in higher EEV in the first 15-min of life (Fig 1A), with better recruitment in the non-gravity dependent (anterior) hemithorax (Fig. 1B), although the geometric centre of aeration was not different. The early improvements in EEV recruitment resulted in quicker attainment of target SpO_2 range and a sustained benefit in oxygenation (Fig 1C-D). Lung reactance was significantly higher reactance in SI_{EIT} and SI_{long} groups in the first three minutes of life, supporting better recruitment. No significant differences were found in broncho-alveolar lavage.

4 Conclusions

In our model, an individualised approach to resuscitation at birth, tailored to patients' lung mechanical properties, was feasible and may be beneficial for preterm neonates.

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