Introduction:
Body positioning affects the configuration and dynamic properties of the chest wall and therefore may influence decisions made to increase or decrease ventilating pressures and tidal volume. We hypothesized that unlike global functional residual capacity (FRC), component sector gas volumes and their corresponding regional tidal expansions would vary markedly in the setting of unilateral pleural effusion (PLEF), owing to shifting distributions of aeration and collapse as posture changed.

Methods:
Six deeply anesthetized swine underwent tracheostomy, thoracostomy and experimental PLEF with 10 ml/kg of radiopaque saline randomly instilled into either pleural space. Animals were ventilated at VT=10ml/kg, frequency=15bpm, I/E=1:2, PEEP=1cmH2O, and FIO2=0.5. Quantitative lung computed tomographic (CT) analysis of regional aeration and global FRC measurements by nitrogen wash-in/wash-out technique were performed in each of these randomly applied positions: semi-Fowler’s (inclined 30° from horizontal in the sagittal plane); prone, supine, and lateral positions with dependent PLEF and non-dependent PLEF (Fig.1).

Results:
No significant differences in FRC were observed among the horizontal positions, either at baseline (p=0.9037) or with PLEF (p=0.58) (Fig.2A). However, component sector total gas volume in each phase of the tidal cycle were different within all studied positions with and without PLEF (p=<.01). Compared to other positions, prone and lateral position with non-dependent PLEF had a more homogenous VT distribution among quadrants (p=.051, Fig.2B). Supine was associated with most dependent collapse (Fig.2C) and greatest tendency for tidal recruitment (48% vs ~22%, p=0.0073, Fig.2D).

Conclusion:
Changes in body position in the setting of effusion-caused chest asymmetry markedly affected the internal distributions of gas volume, collapse, ventilation, and tidal recruitment, even when commonly used global FRC measurements provided little indication of these important positional changes.
Nomenclature For Analysis of Regional Aeration: I. Supine and II. Prone, where quadrants were defined as: Non-PLEF Dorsal (A); Non-PLEF Ventral (B); PLEF Dorsal (C); and PLEF Ventral (D). III. Lateral position with “Dependent Pleural Effusion”, where quadrants were defined as: Non-PLEF, Non-Dependent Dorsal (A); Non-PLEF, Non-Dependent Ventral (B); PLEF Dependent Dorsal (C); and PLEF Dependent Ventral (D). IV. Lateral position with “Non-Dependent Pleural Effusion”, where quadrants were defined as: Non-PLEF, Dependent Dorsal (A); Non-PLEF, Dependent Ventral (B); PLEF, Non-Dependent Dorsal (C); and PLEF Non-Dependent Ventral (D). PLEF: Pleural Effusion, *: anatomical distribution of PLEF.

Image 2:

A. Global FRC response to body position; B. Distribution of tidal ventilation; C. Positional Changes in End-Expiratory Collapsed Volume; D. Positional Changes in Tidal Recruitment.