Introduction:
Tidal volume delivered by mechanical ventilation (MV) in sedated patients is distributed preferentially to ventral alveoli, causing overdistention and associated collapse in dorsal alveoli, driving volutrauma, atelectrauma and ventilator-induced lung injury. [1] Temporary transvenous diaphragm neurostimulation (TTDN) stimulates diaphragm contraction. [2] When used in synchrony with MV, TTDN encourages increased dorsal ventilation due to the change in pressure gradients with diaphragm contraction, mimicking a more normal physiological pattern. This may improve gas exchange and reduce injury.

Methods:
A pilot study was conducted using 50 kg pigs undergoing MV in a mock ICU. Deeply sedated subjects were provided lung-protective volume-control ventilation at 8 ml/kg. TTDN diaphragm contractions were delivered in synchrony with inspiration on every second breath, reducing the ventilator pressure-time-product by 15-20% during MV+TTDN breaths. Tidal volume distribution was recorded in each condition using electrical impedance tomography, and compared to never-ventilated, spontaneously breathing subjects (NV).

Results:
Dorsal ventilation changed from 49% during MV breaths to 54% during MV+TTDN breaths, compared to 60% in the NV group (p=0.035). Ventral ventilation changed from 51% during MV breaths to 46% during MV+TTDN breaths, compared to 40% in the NV group (p=0.042, Figure 1).

Conclusion:
TTDN diaphragm contraction used as an adjunct to MV yields a more physiological pattern of volume distribution. This translates into less overdistension in the ventral areas and less atelectrauma in the dorsal areas and reduces ventilator-induced lung injury. This technology has the potential to provide a novel method of lung-protective ventilation.

References:
Figure 1: TTDN redistributes tidal volume during mechanical ventilation toward a more physiological pattern.