

Magnetic phrenic nerve stimulation to prevent diaphragm dysfunction under mechanical ventilation (STIMIT®): Randomized controlled experimental study

L. Felipe Damiani, Mayson L. A. Sousa, Vanessa Hsing, Annia Schreiber, Clement Brault, Ewan Goligher, Darlene Reid, Arthur S Slutsky, Martin Post, Laurent Brochard

Background: Diaphragm atrophy and dysfunction due to insufficient breathing effort can affect close to 50% of mechanically ventilated patients. Temporary phrenic nerve stimulation (PNS) may facilitate spontaneous breathing and mitigate diaphragm atrophy and weakness. The objective of this study was to compare the effect of non-invasive bilateral phrenic nerve stimulation using STIMIT® versus a control group on diaphragm function, structure, respiratory mechanics, and gas exchange in an experimental model of acute lung injury.

Methods: Fifteen pigs (35±5kg) were anesthetized, mechanically ventilated, and monitored for 12 hours. Lung injury was induced by surfactant depletion and high-stress ventilation to reach PaO₂ <150 mmHg. After lung injury, recruiting maneuver and baseline measurements, pigs were randomized in one of our three groups; 1. *CONTROL*: Passive MV with no PNS; 2. *STIMIT4*: non-invasive bilateral PNS using STIMIT® synchronized to the ventilator performed for 15 minutes every 4 hours; 3. *STIMIT8*: non-invasive bilateral PNS using STIMIT® synchronized to the ventilator performed for 15 minutes every 8 hours. Diaphragm function was assessed by measuring transdiaphragmatic twitch pressure (PdiTw) at baseline, 4, 8, and 12 hours of ventilation and reported as a relative change over time. Diaphragm thickness at end of expiration was evaluated by ultrasound at baseline and 12 hours. Electrical impedance tomography was measured throughout the whole protocol.

Results: No difference was observed in ventilatory variables, respiratory mechanics, hemodynamics and PaCO₂ levels between the 3 experimental groups at baseline and throughout the study protocol. Compared with *CONTROL* and *STIMIT8*, the *STIMIT4* group had a significantly greater increase in PdiTw (46±23% vs 4±21% and 1±11% respectively; p=0.014; Figure 1). Delta change in end-expiratory diaphragm thickness was not statistically different after 12 hours of mechanical ventilation. Overall, distribution of ventilation was not different between groups, but a significant less decreased in end-expiratory lung volume was observed in *STIMIT4* group as compared with *CONTROL* group (-0.02±0.6L vs -1.0±1.5L, p=0.019).

Conclusion: Magnetic PNS using STIMIT seems to be a feasible and safe strategy to promote spontaneous breathing efforts. PNS might preserve diaphragm function and maintain end expiratory lung volume.

Figure 1

