

Coactivation of Expiratory Muscles and Diaphragm During, Electrical Stimulation to the Abdominal Wall

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Introduction: Preliminary observations suggest that transcutaneous electrical stimulation of the abdominal wall muscles during exhalation may reduce duration of mechanical ventilation despite not increasing expiratory muscle dimensions (McCaughey. Crit Care 2019;23:261). The expiratory muscles and the diaphragm are coactivated during mechanical stabilization of the trunk and during expulsive efforts. Whether abdominal wall stimulation during exhalation causes diaphragmatic coactivation and, thus, contributes to the (purported) stimulation-associated reduction in duration of mechanical ventilation is unknown. Hypothesis: Electrical stimulation of the abdominal wall causes coactivation of the expiratory muscles and of the diaphragm.

Methods: Transdiaphragmatic pressure (Pdi) and electrical activity of the diaphragm (EAdi) in 10 participants (5 patients with COPD, 5 healthy subjects) were recorded during 2 minutes of resting breathing and during 10 minutes of abdominal stimulation. The stimulation current was set to near-maximally tolerated intensity. **Results:** Tidal increase of Pdi (Δ Pdi) during exhalation before stimulation was 0.50 ± 0.27 cm H₂O (mean $\pm$ SE) in the COPD group and 0.0 ± 0.0 cm H₂O in the healthy group. One minute into expiratory muscle stimulation, Δ Pdi during exhalation had increased to 6.11 ± 2.75 cm H₂O in the COPD group and to 12.95 ± 2.49 cm H₂O in the healthy group ($p < 0.027$). Ten minutes later, Δ Pdi during exhalation in both groups was approximately half the value at one minute, but still greater than Δ Pdi before stimulation ($p < 0.025$). EAdi signal during exhalation was saturated by the discharge of the electrical stimulator. Accordingly, it is unclear whether the modest increases in Δ Pdi during electrical stimulations resulted from passive stretching of the muscle or (pliometric) diaphragmatic contractions. In the COPD group, the mean Δ Pdi during exhalation was never greater than the mean Δ Pdi recorded during inhalation. In the healthy group, Δ Pdi during exhalation was inconsistently and modestly greater than Pdi recorded during inhalation. **Conclusion:** Electrical stimulation of the abdominal wall muscles causes modest tidal increases in transdiaphragmatic pressure. It is unlikely that such modest coactivation (or passive stretching) of the diaphragm can achieve muscle conditioning. **Support:** Veterans Administration Research Service, Liberate Medical LLC, National Science Foundation (Grant No. 1632402).

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