MONITORING EXHALE AND LUNG VOLUME IN DIVERS USING ELECTRICAL IMPEDANCE TOMOGRAPHY

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Introduction: Lung volume can be reduced either through increased pressure during a breath-hold dive, or by exhaling. While both processes result in reduction of lung volume, only the exhale decreases the amount of lung gas. In this study, we wanted to compare these two mechanisms to assess whether they produce similar regional changes in lung air distribution. We hypothesize that regional air movement within the lungs is different during these mechanisms. We used Electrical Impedance Tomography (EIT), modified for underwater use [1] to image lung air distribution.

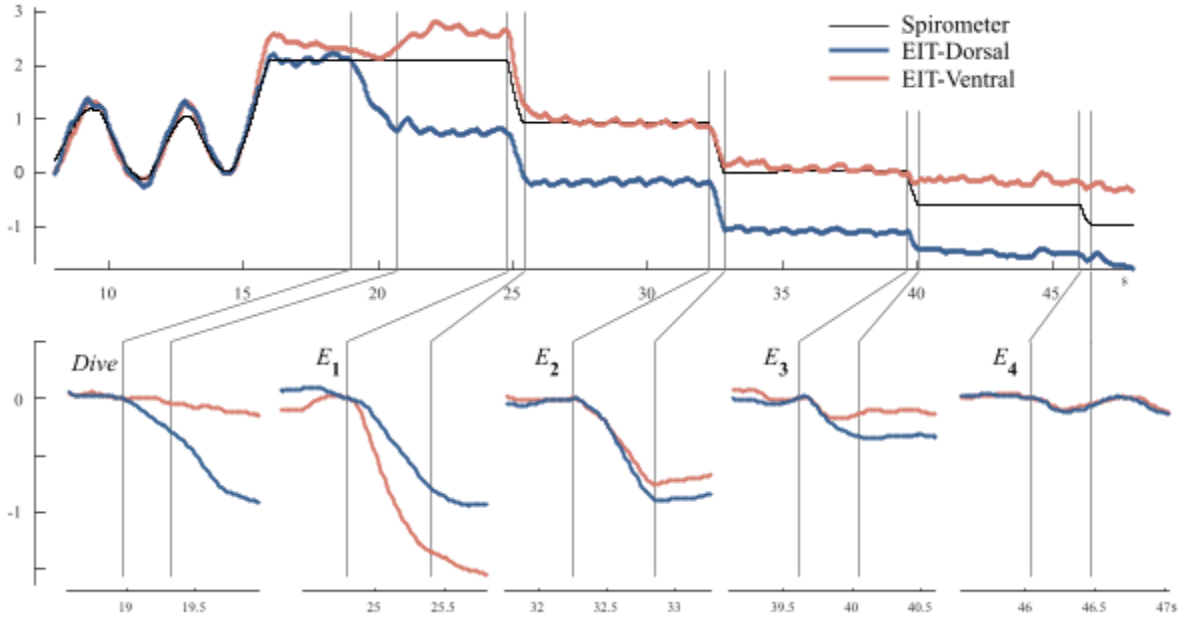

Figure 1: Spirometer, regional EIT signals, and event sequence (top) for an experiment. A dive (surface to 1m depth) was followed by four exhales at depth (E_1 ... E_4). Bottom: expanded time axis for each event

Methods: Ongoing research consisted of 3D EIT electrode belts (as per [1]) placed circumferentially onto participants' (N=5) chests. Participants breathed through a snorkel attached to a spirometer. Starting at the surface, participants were pushed to 1m depth (*Dive*) and then exhaled four times (E_1 ... E_4) at depth (figure 1). EIT images were reconstructed with dorsal and ventral lung regions analyzed. The distribution of flow between the dorsal and ventral ROIs was calculated. Each participant was tested in prone and supine postures.

Results: Clear difference in dorsal-to-ventral flow was observed between the dive and exhales. These differences often reversed between the two postures. Large variations between subjects are seen.

Discussion and Conclusions: Results show that EIT can be used reliably to obtain real-time data of human participants underwater. This opens the opportunity for future studies to further the understanding of diving related lung injuries and mechanics.

Reference: [1] Adler et al. (2025) Physiol Meas, 46:03NT01