SUPPLEMENTARY MATERIAL

Airway dynamics in COPD patients by within-breath impedance tracking: effects of continuous positive airway pressure

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Figure S1. Schematics of the forced oscillation setup. Respiratory impedance (Zrs) was measured with a custom-made FOT setup consisting of a wave-tube for the estimation of Zrs, a screen pneumotachograph (model PDD 301, Piston Medical Inc., Budapest, Hungary) for the recording of the tidal flow (V') and a loudspeaker for the generation of the forced oscillatory signal. Volume (V) was obtained via numerical integration of V'. A sinusoidal signal with a frequency of 8 Hz and an amplitude of <0.3 hPa was superimposed on spontaneous breathing for 24 s. Three recordings were collected and the one with the most even breathing pattern was selected for within-breath analysis. In a subgroup of COPD patients, measurements were also made at elevated airway pressures of 4, 8, 14 and 20 hPa generated by a CPAP device (Trilogy 100, Philips Respironics, Murrysville, PA). ICS Model 33NA002D transducers (ICSensors, Miltipas, CA) were used for the measurements of the inlet (P1) and outlet (P2) pressures of the wave tube and the pressure difference across the pneumotachograph. The subjects breathed atmospheric air through a breathing tube or connected to a CPAP device.

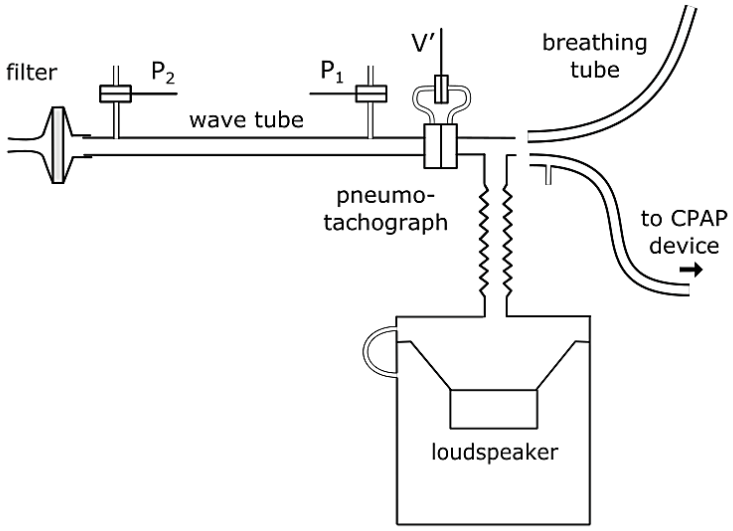


Figure S2. Illustration of quantities derived from the reactance (Xrs) vs volume (V) or flow (V') loops. Open and closed circles indicate data points from inspiration and expiration, respectively. See Table 1 in the main text for definitions of quantities. The Xrs *vs* V (right) and Xrs *vs* V' (left) loop areas (AXV and AXV', respectively) are shaded in light grey.

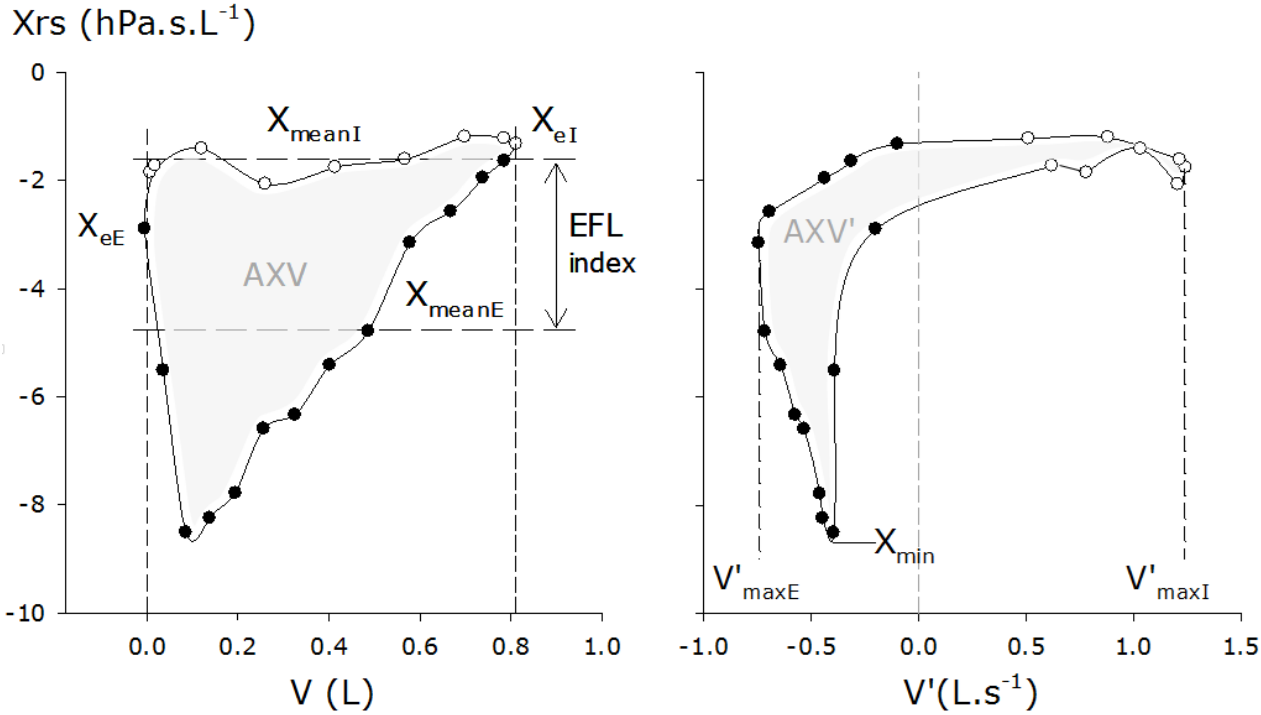
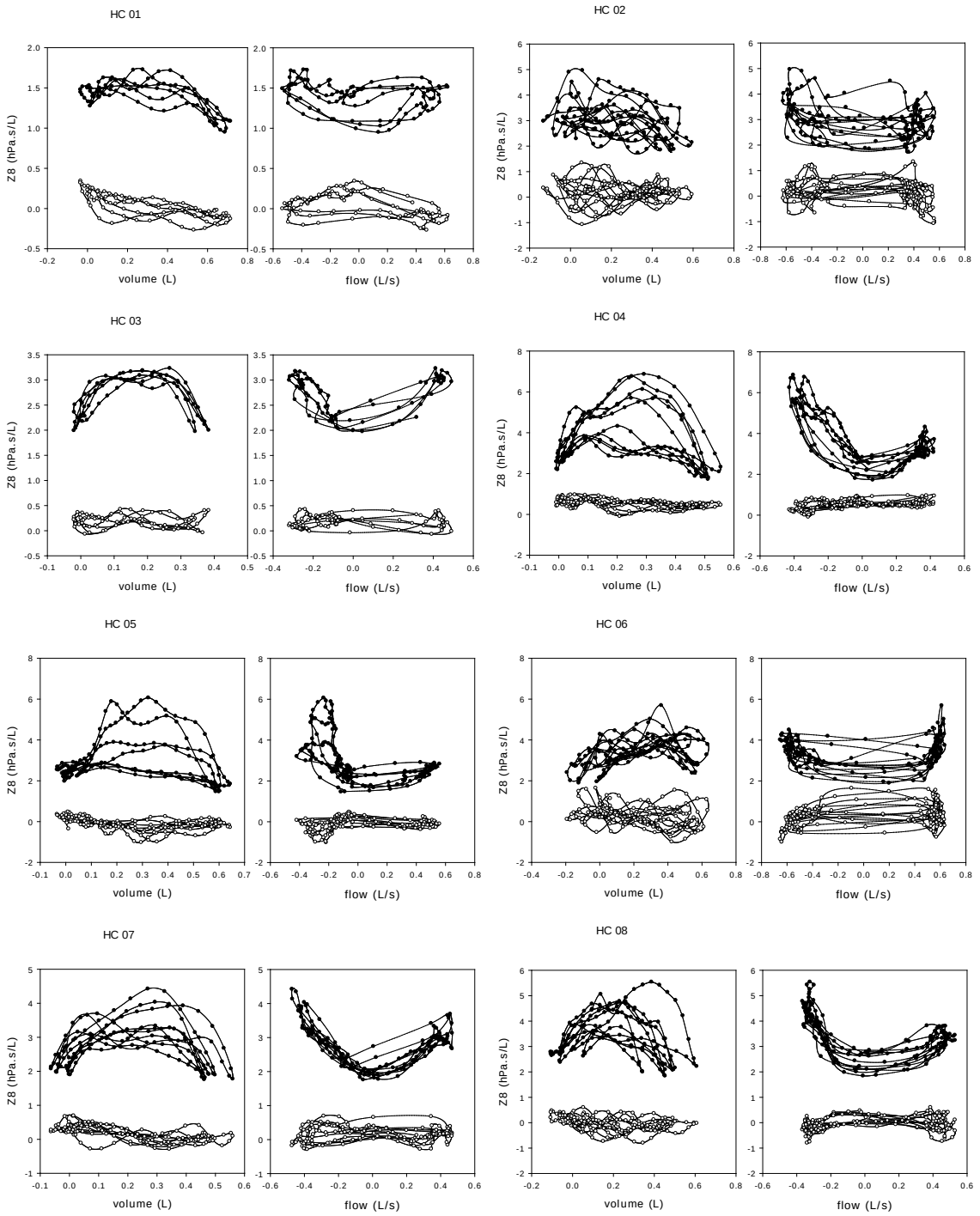


Figure S3. Respiratory resistance (R8, closed circles) and reactance (X8, open circles) at 8 Hz plotted against volume and flow in the healthy controls HC01-HC20.



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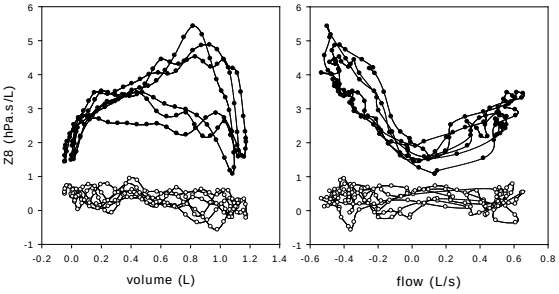

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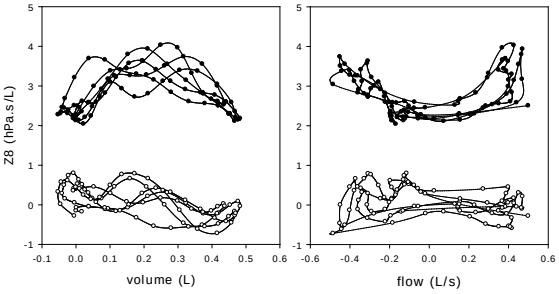

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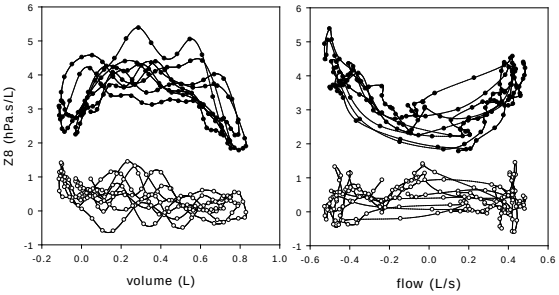

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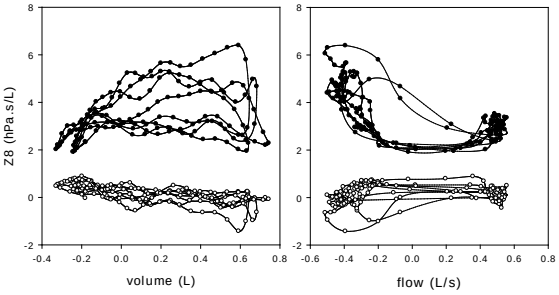

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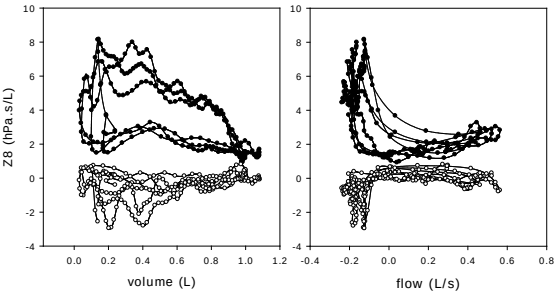

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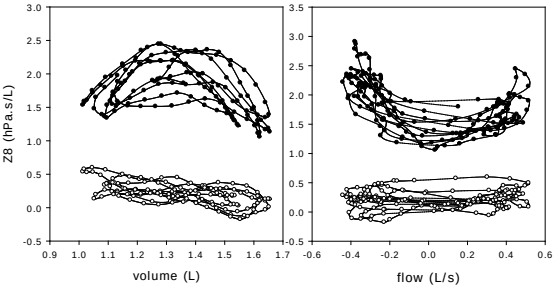

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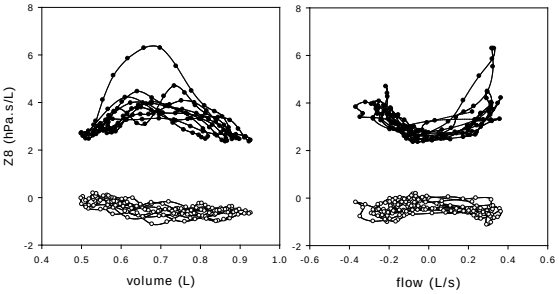

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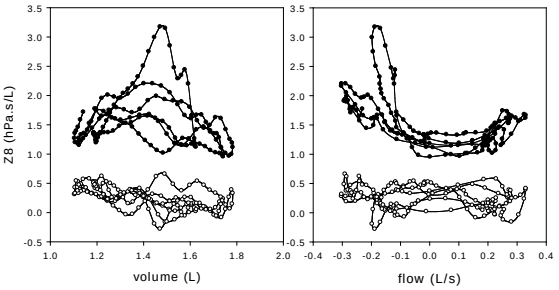

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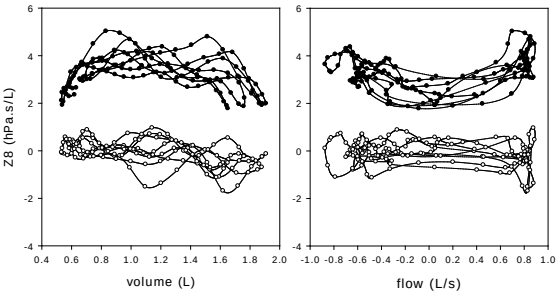

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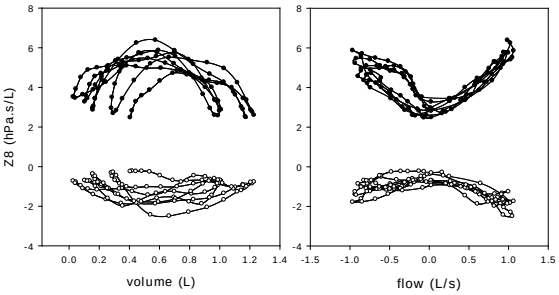

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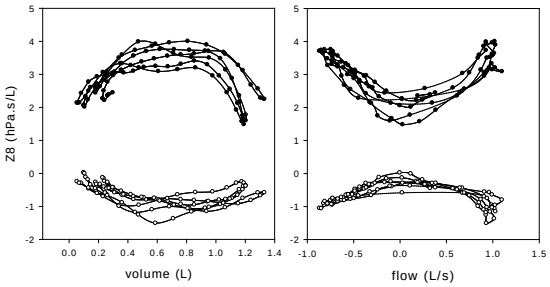

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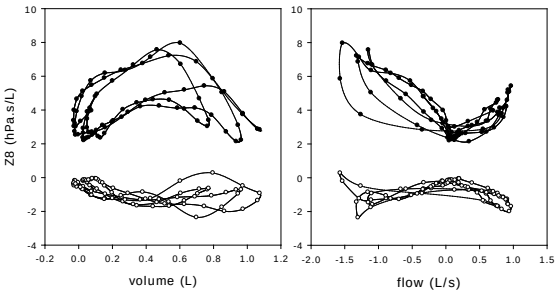
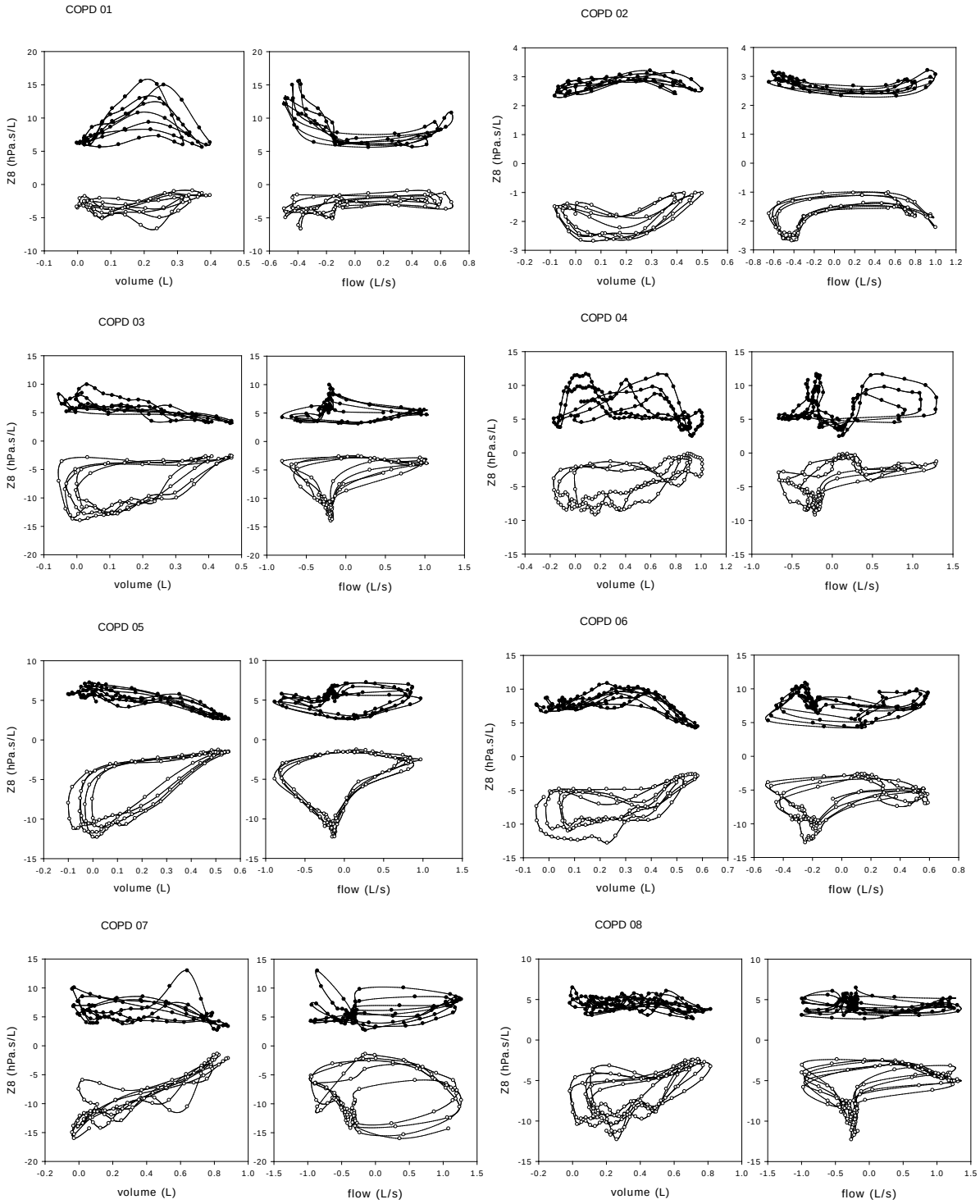


Figure S4. Respiratory resistance (R8, closed circles) and reactance (X8, open circles) at 8 Hz plotted against volume and flow in the COPD patients (COPD 01-43 and CPAP 01-12).



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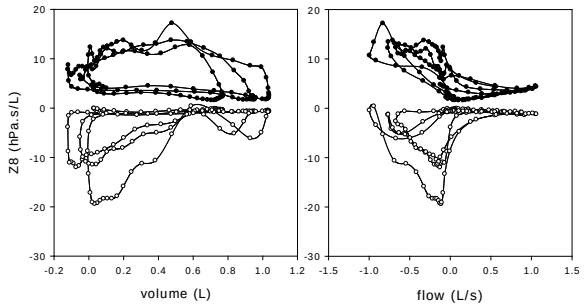

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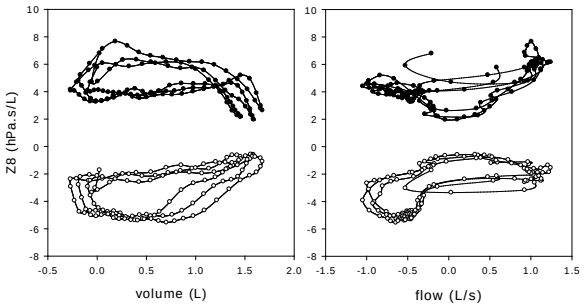

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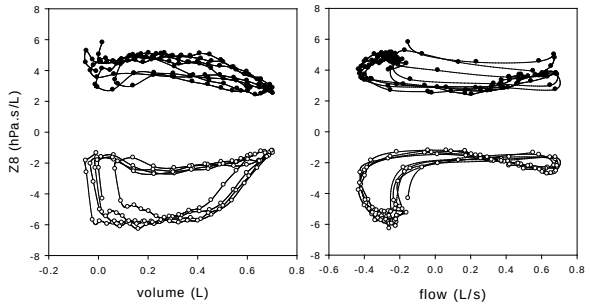

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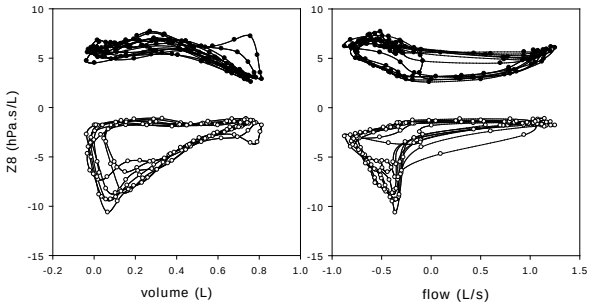

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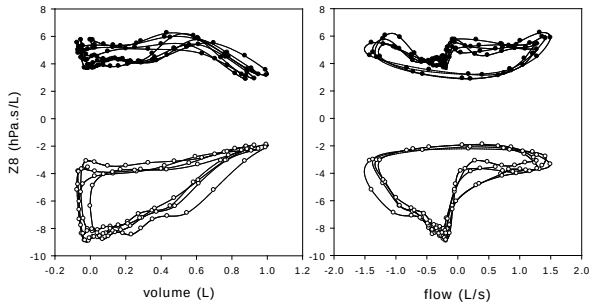

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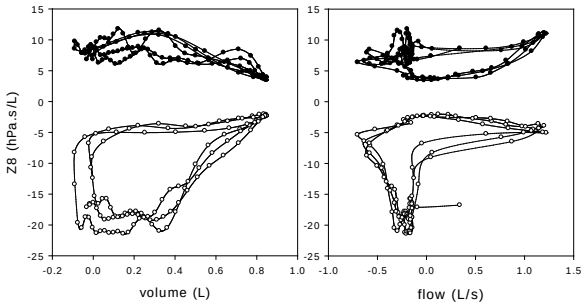

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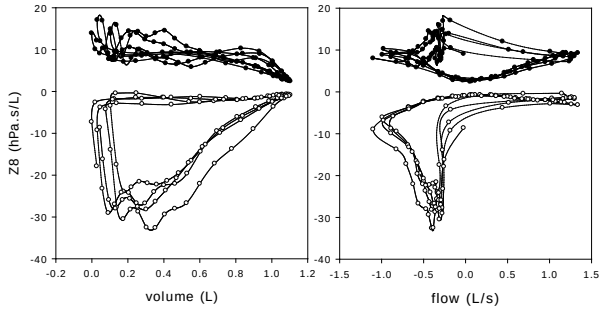

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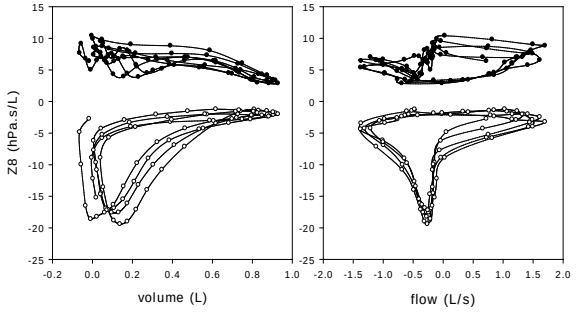

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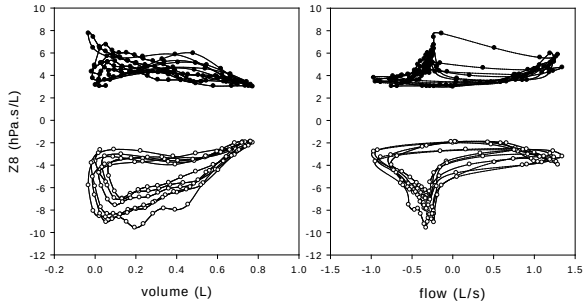

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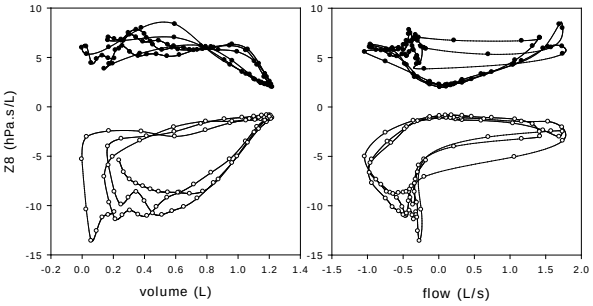

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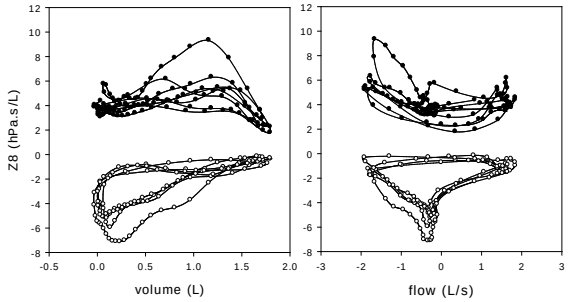

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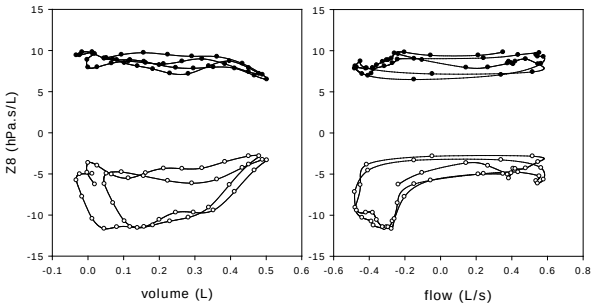

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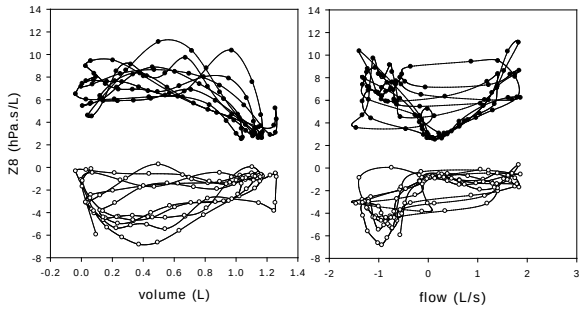

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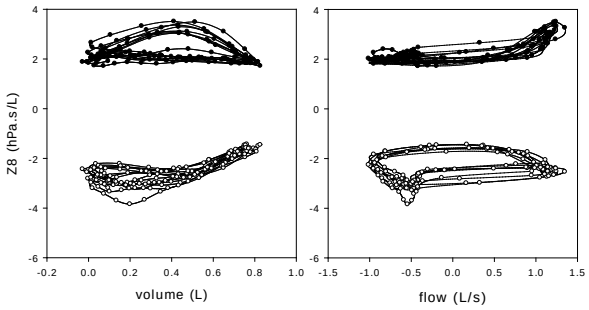

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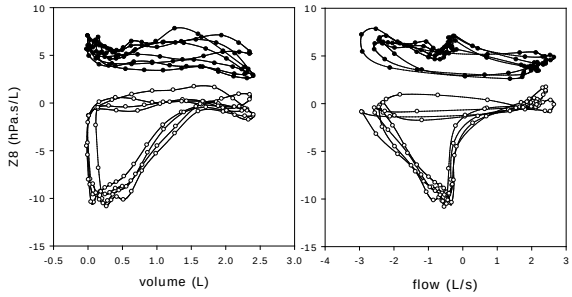

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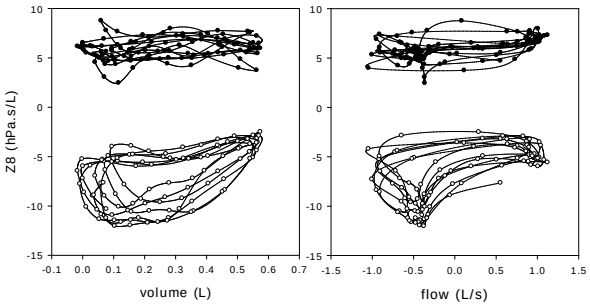

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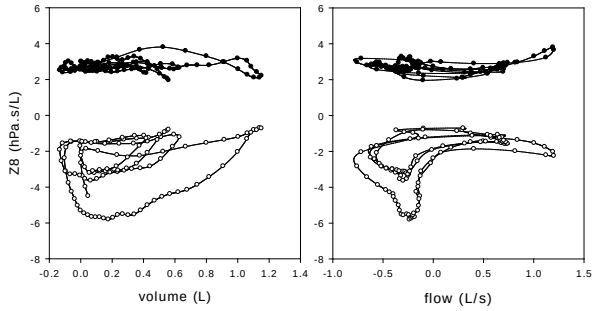

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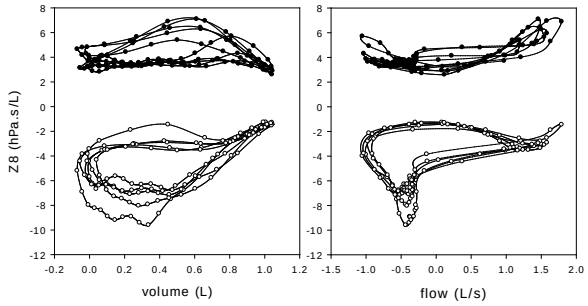

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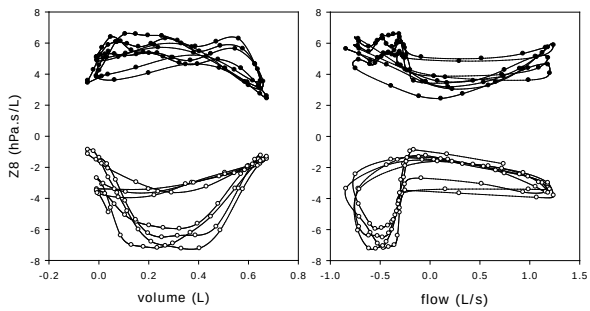

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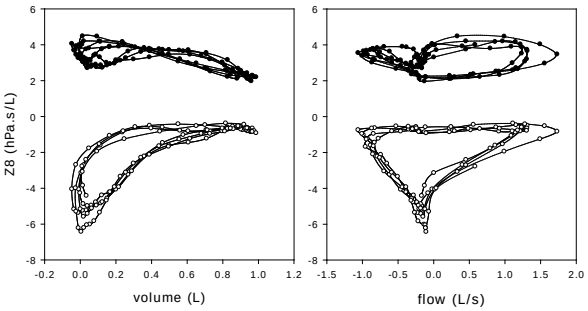

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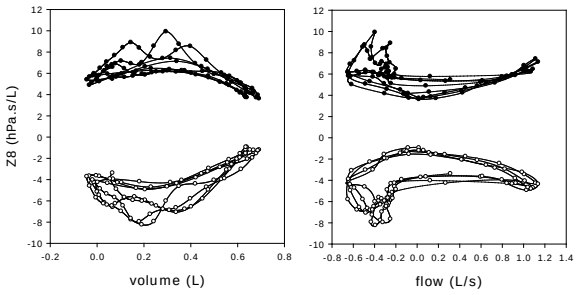

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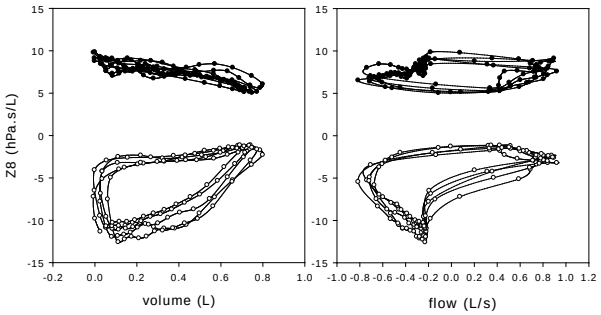

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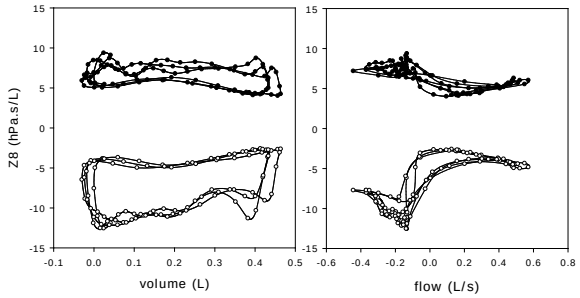

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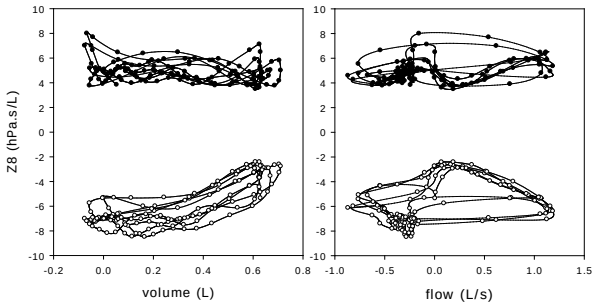

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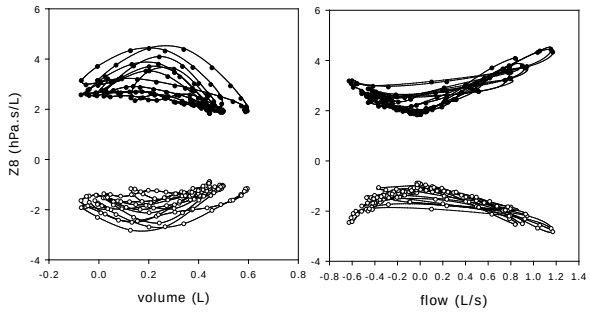

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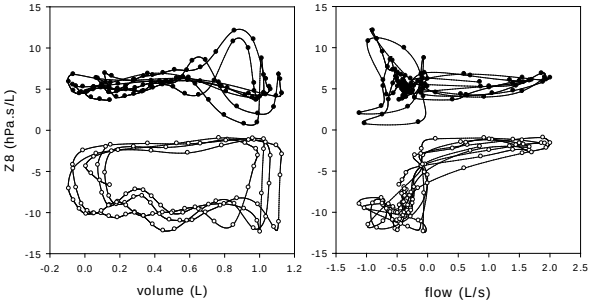

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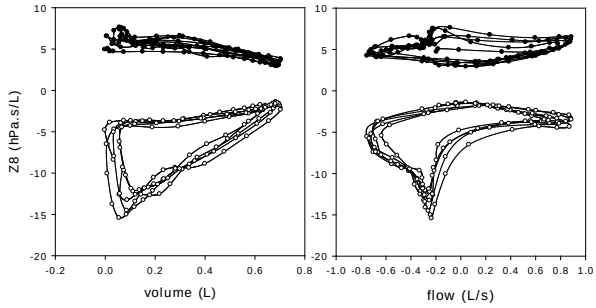

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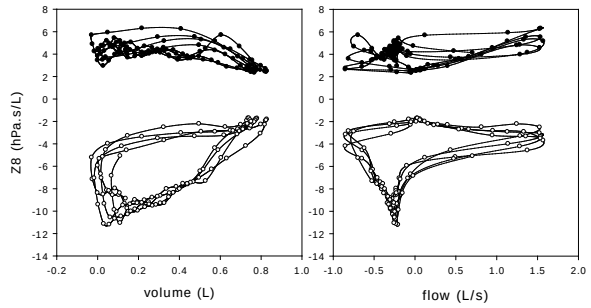

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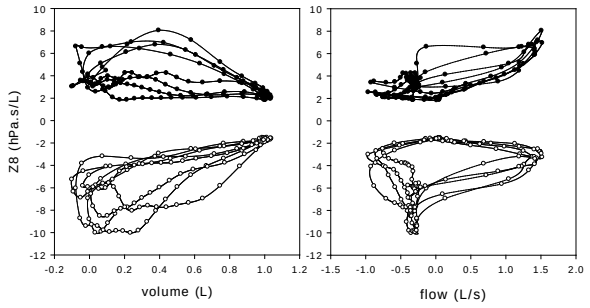

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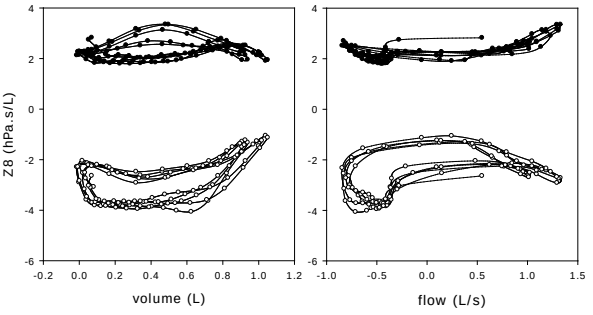

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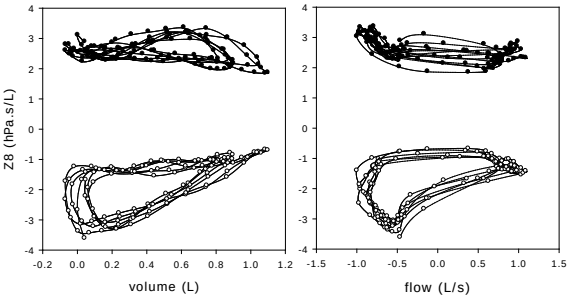

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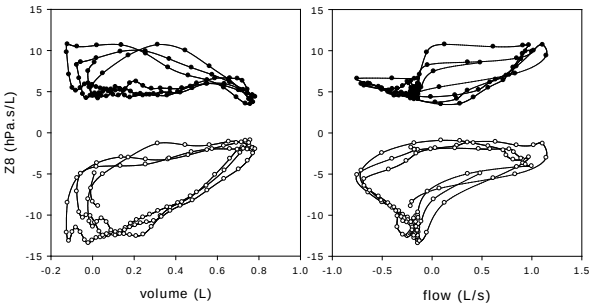

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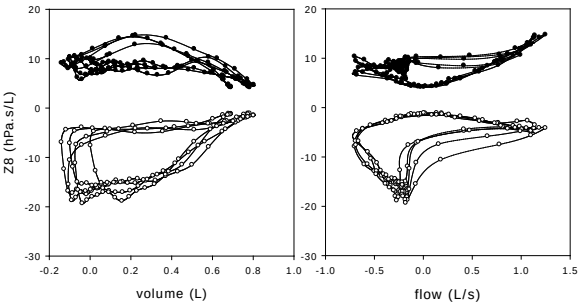

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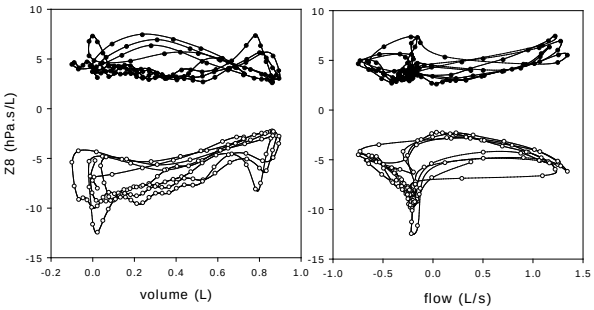

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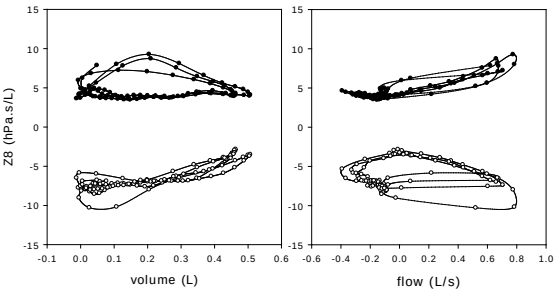

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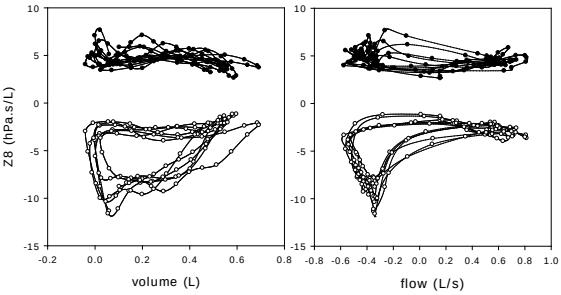

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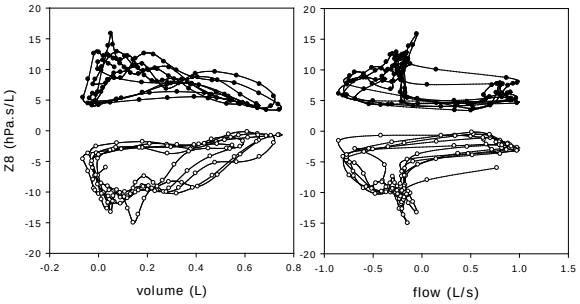

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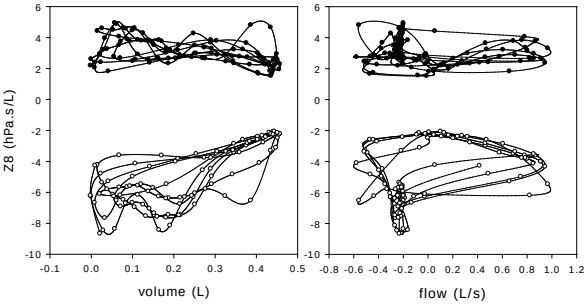

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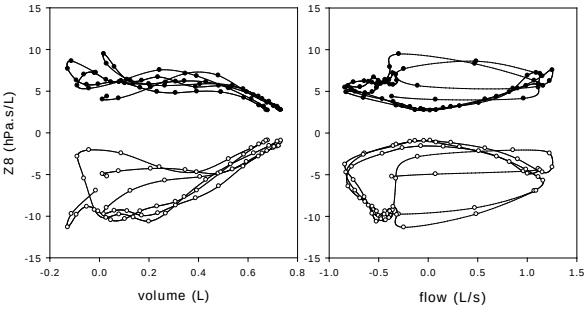

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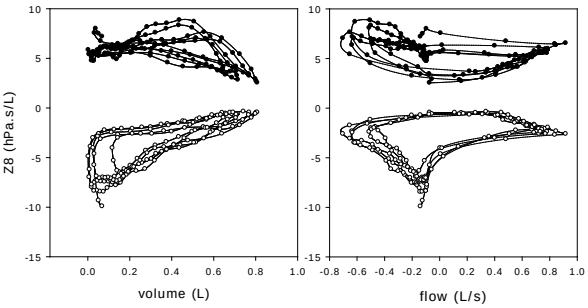

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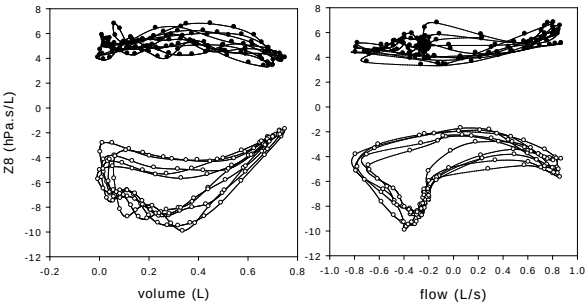

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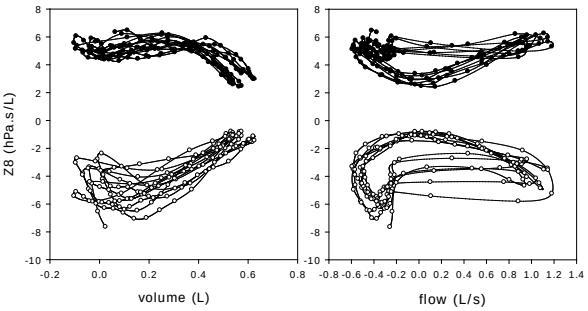

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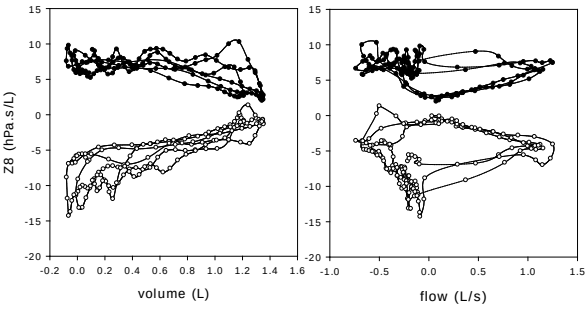

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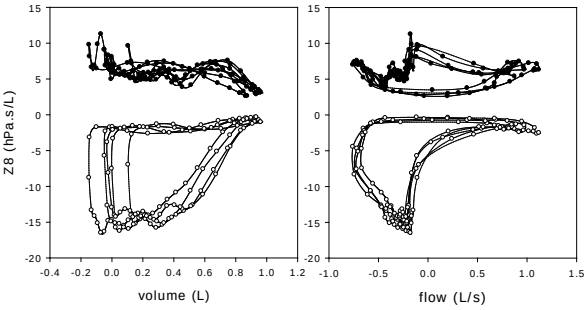

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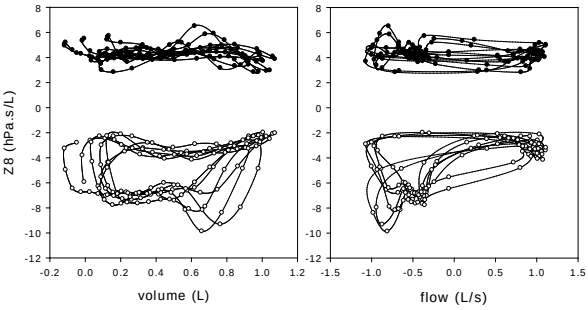

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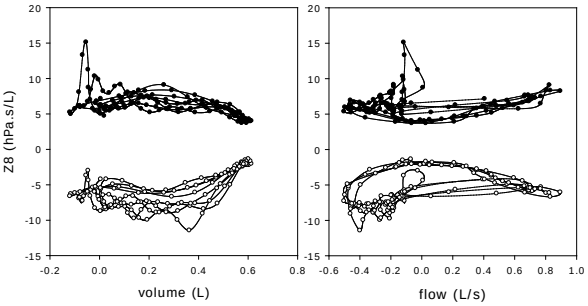


CPAP 12

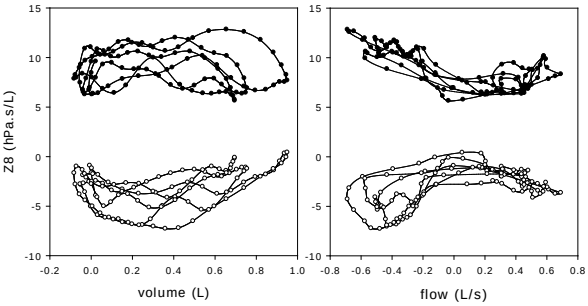
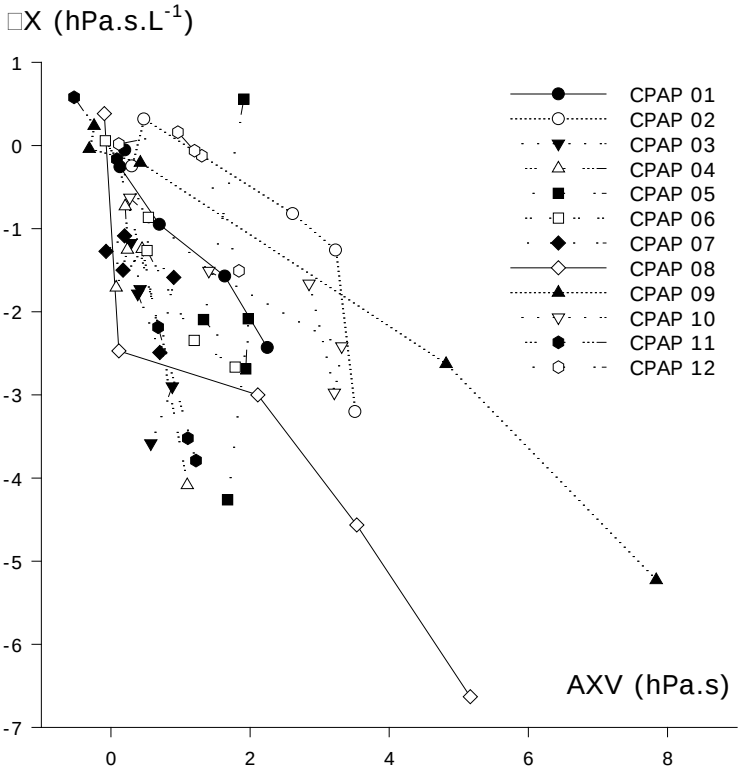


Figure S5. Differences in reactance between end expiration and end inspiration (ΔX) plotted against reactance-volume area (AXV) in individual COPD patients at CPAP levels of 0, 4, 8, 14 and 20 hPa. The changes in ΔX and AXV are simultaneous (e.g. patients 01, 09, 11) or dissociated (patients 05, 08).



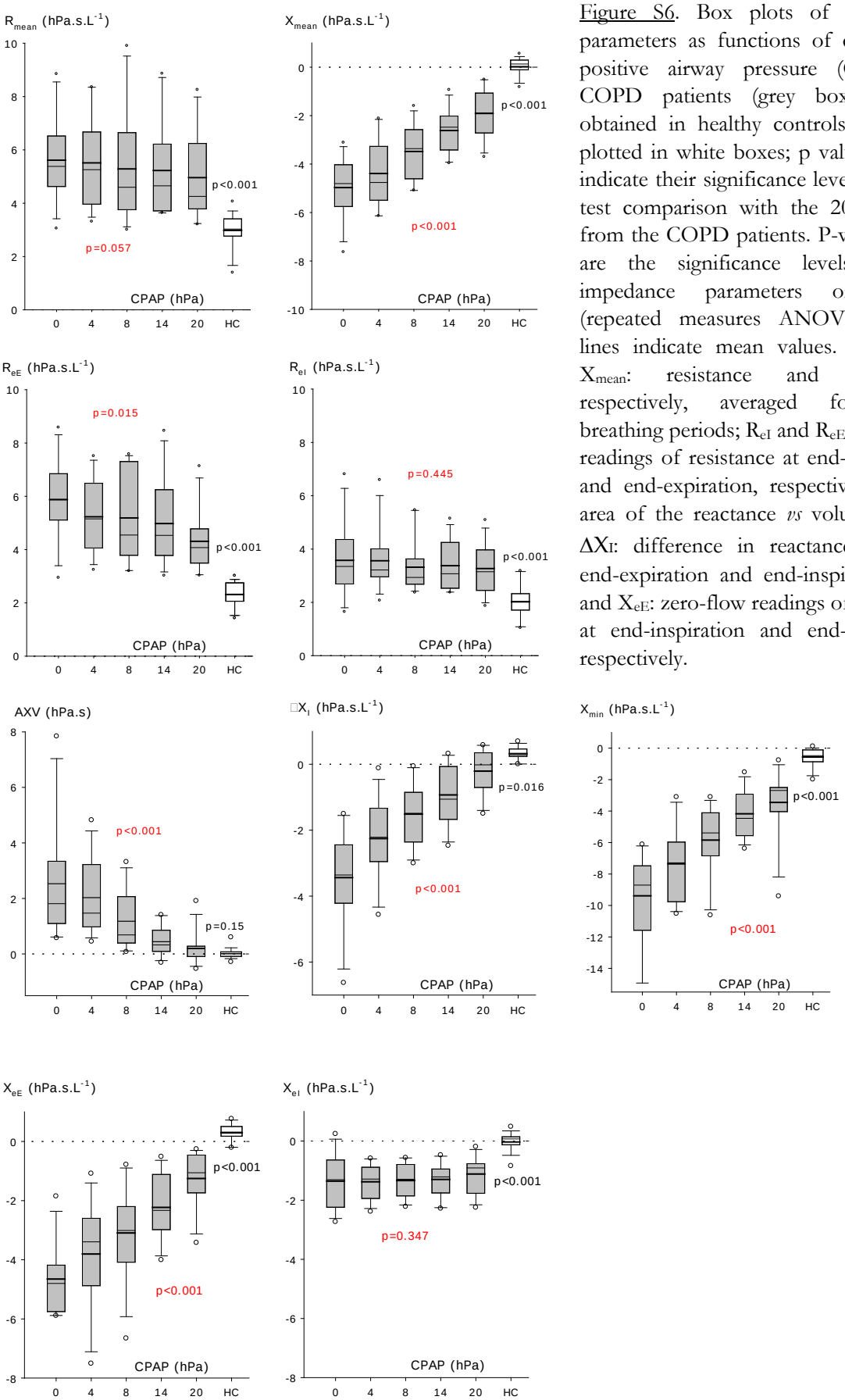


Figure S6. Box plots of impedance parameters as functions of continuous positive airway pressure (CPAP) in COPD patients (grey boxes). Data obtained in healthy controls (HC) are plotted in white boxes; p values (black) indicate their significance levels in the t-test comparison with the 20-hPa data from the COPD patients. P-values (red) are the significance levels of the impedance parameters on CPAP (repeated measures ANOVA). Thick lines indicate mean values. R_{mean} and X_{mean}: resistance and reactance, respectively, averaged for whole breathing periods; R_{eI} and R_{eE}: zero-flow readings of resistance at end-inspiration and end-expiration, respectively; AXV: area of the reactance *vs* volume loops; ΔX_I: difference in reactance between end-expiration and end-inspiration; X_{eI} and X_{eE}: zero-flow readings of resistance at end-inspiration and end-expiration, respectively.