The Mueller maneuver attenuates left atrial phasic volumes and myocardial strain in healthy younger adults

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Background: Negative intrathoracic pressure swings alter cardiac loading conditions, which may impact left atrial hemodynamic function and augment atrial stress. If such changes occur and are repeated chronically, they may contribute to the marked atrial remodeling seen in states associated with forceful inspiratory efforts such as endurance training or obstructive sleep apnea.

Purpose: We studied the acute effects of static inspiratory efforts on left atrial chamber function, myocardial mechanics, and diastolic function.

Methods: We included healthy adults (10M/7F, 24±4 years) and used Mueller maneuvers to reduce intrathoracic pressure to a −30 cmH2O target for 15 seconds. Over 6 repeated trials, we used echocardiography to acquire left atrial and ventricular focused 2D images, and mitral Doppler inflow and annular tissue velocity spectra. Images were analyzed offline to determine left ventricular volumes, tissue relaxation velocities, trans-mitral filling velocities, and phasic left atrial volumes and myocardial strain using speckle-tracking imaging. Repeated measures were made at Baseline, within the last 5 seconds of the Mueller maneuver, and within the first 5 seconds after release, with 3–5 cardiac cycles averaged per measurement.

Results: Compared to Baseline, hemodynamic changes occurred during the late phase of the Mueller maneuver and immediately after release. Left ventricular stroke volume decreased by −10±4 mL (p < 0.05) then returned to baseline upon release; this was associated with a −11±9 mL (p < 0.05) reduction in end-diastolic volume. Left ventricular early diastolic filling attenuated, reflected by decreases in mitral annular relaxation velocity (−2±2 cm/s, p < 0.05), E-wave filling velocity (−13±14 cm/s, p < 0.05), and left atrial passive emptying volume (−5±5 mL, p < 0.05), each normalizing upon release. Left atrial maximal volume decreased (−5±5 mL, p < 0.05) during the Mueller maneuver, but increased relative to baseline (+4±5 mL, p=0.049) following release, while left atrial peak positive longitudinal strain decreased (−6±6%, p < 0.05) and normalized upon release.

Conclusions: Attenuated left atrial and in turn ventricular filling may contribute to acute stroke volume reduction during forceful inspiratory efforts. Rapid changes in left atrial chamber volumes and myocardial strain with the release of forceful inspiratory efforts may reflect acute left atrial stress.