A photograph showing a person submerged in a water tank, wearing a diving mask and connected to various medical tubes and equipment. A Philips monitor in the background displays echocardiography data. The scene is set in a laboratory or clinical environment.

Using Transthoracic Echocardiography during Head Out Immersed Exercise in Cold Water to Study Swimming Induced Pulmonary Edema (SIPE)

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Background: SIPE

- First described by Wilmshurst in 1989
- Hemoptysis, dyspnea and hypoxemia develop after swimming or diving, often in the young and fit
- Problematic in Special Forces trainees and triathletes
- Immersion, cold, exertion, tight wet suits, fluid loading have been considered risk factors
- Most victims quickly improve with no or minimal treatment once out of water, but hospitalization may be necessary, and death can occur
- The most compelling evidence favors a hemodynamic cause from immersion induced volume redistribution added to pulmonary hypertension from exertion



SIPE is an issue for recruits during BUDS training

20 to 30 cases observed a year in combat swimmer recruits.

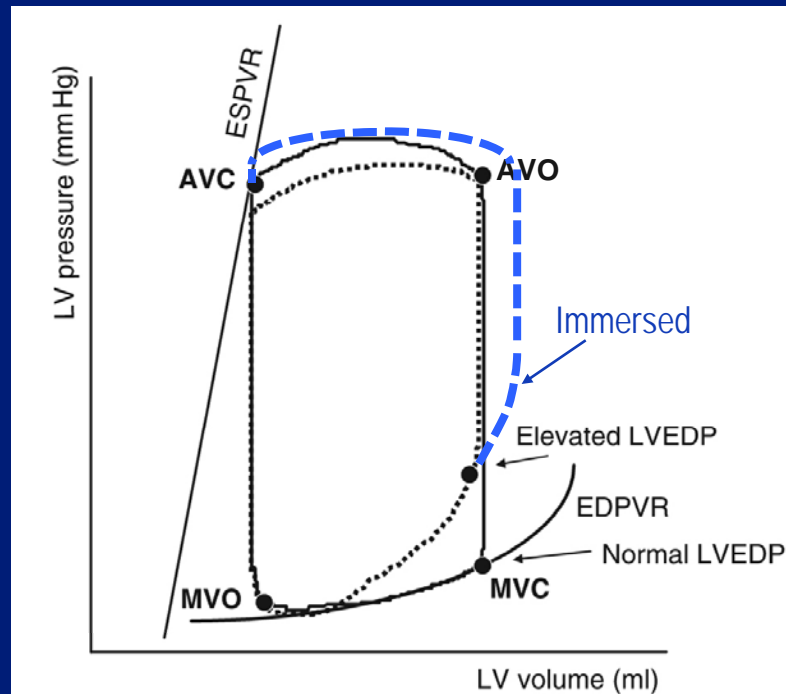


Triathlon Start

Websites urge participant to be a selfish swimmer with tips to deal with the “anxiety” of the start. Swimmers urged to float on your back if you get too anxious.

Hypothesis

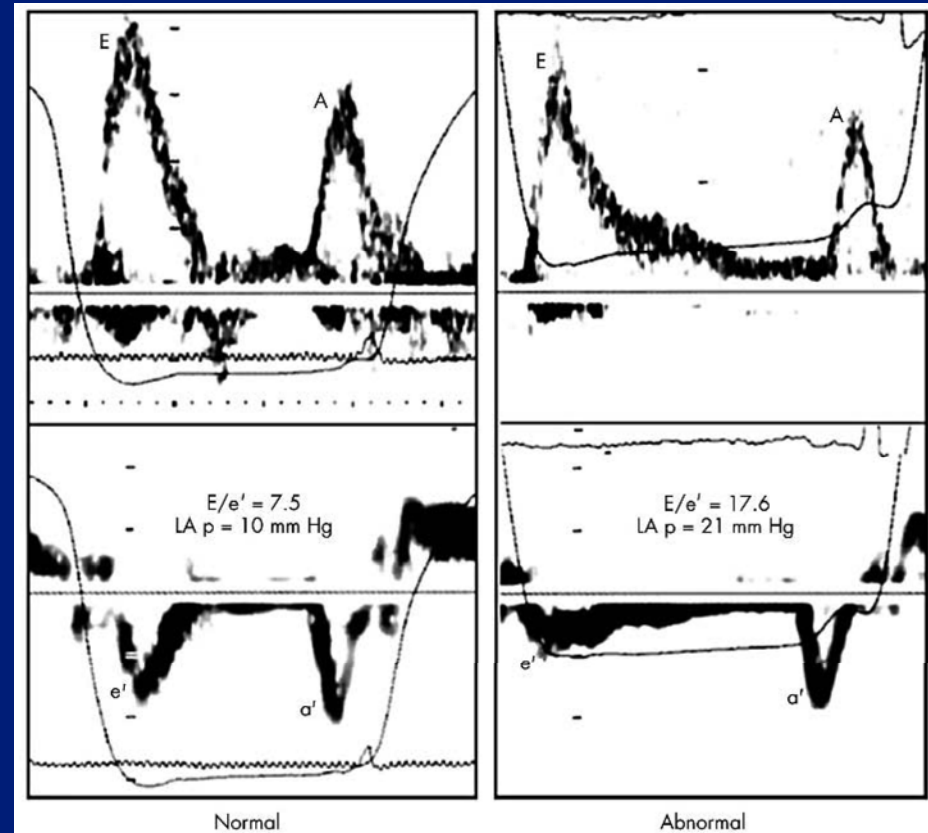
SIPE susceptible individuals respond to cold water immersed exercise with excessive elevations of PA pressures due to impaired diastolic LV filling



Methods

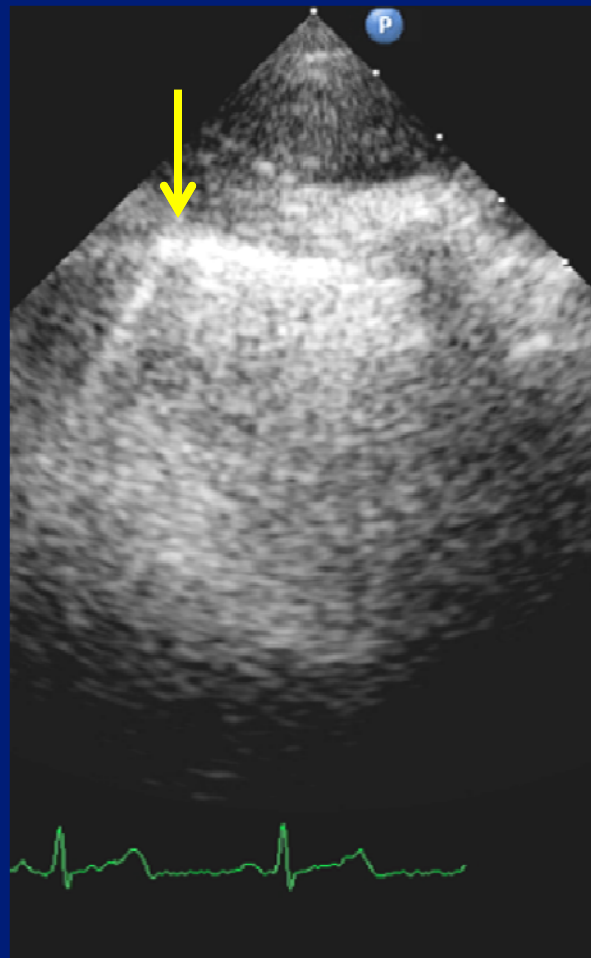
- Normal volunteers and previous SIPE victims
- All subjects must have TR jet
- Exercise 40 minutes immersed in 20° C water
- TTE before, during and after exercise
- MRI to check lung water in selected patients
- Echo parameters measured included RVSP, IVC diameters, E/e', E/A ratios, LV strain and search for “comet tails”

Measurement of E/A and E/e'

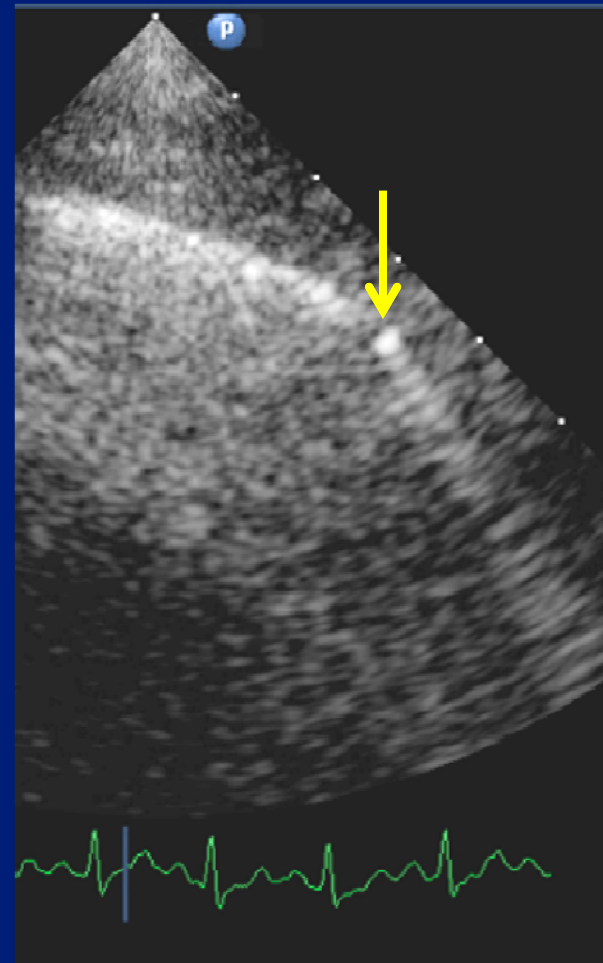


Comets

Detected wet and dry



resting dry

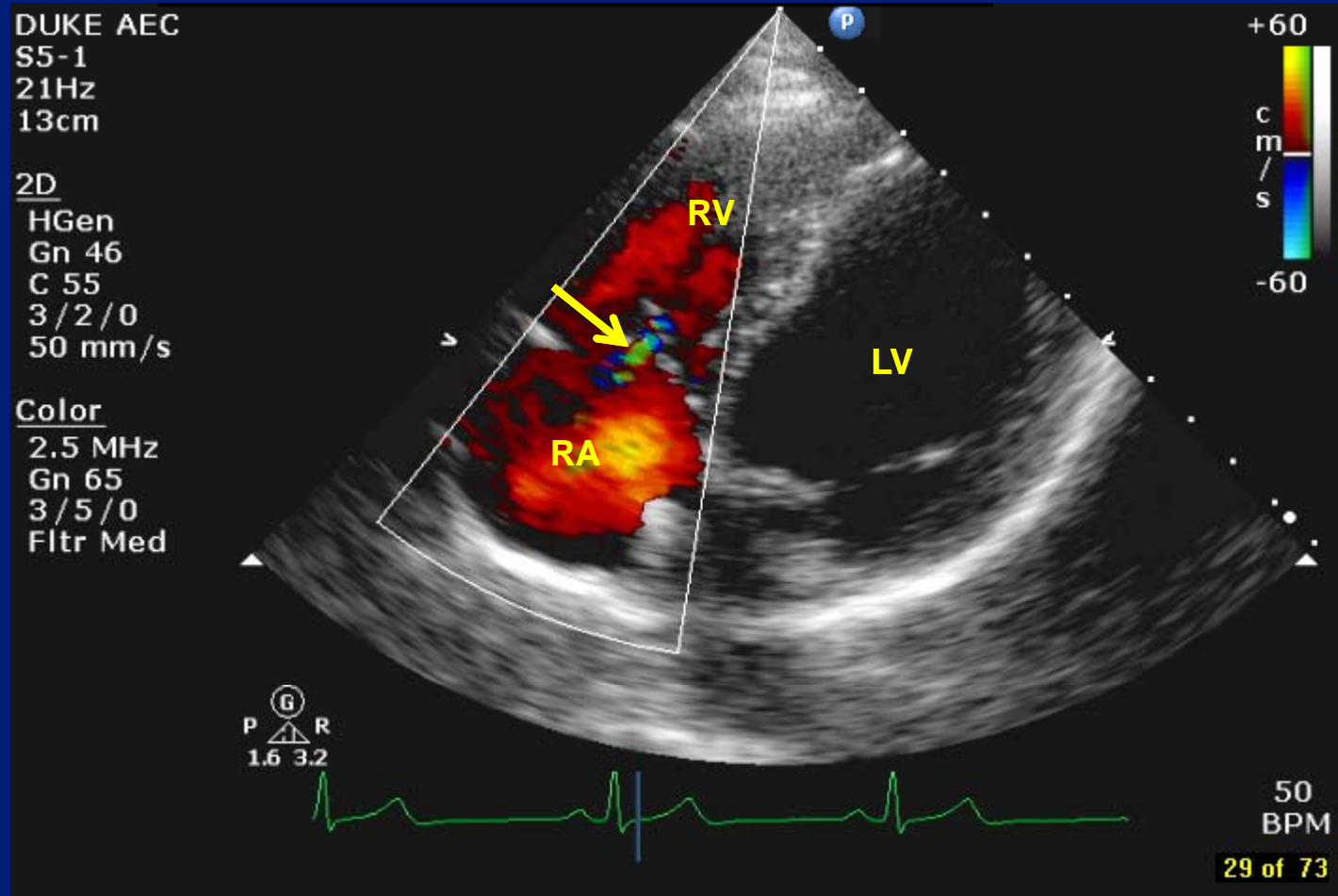


min wet

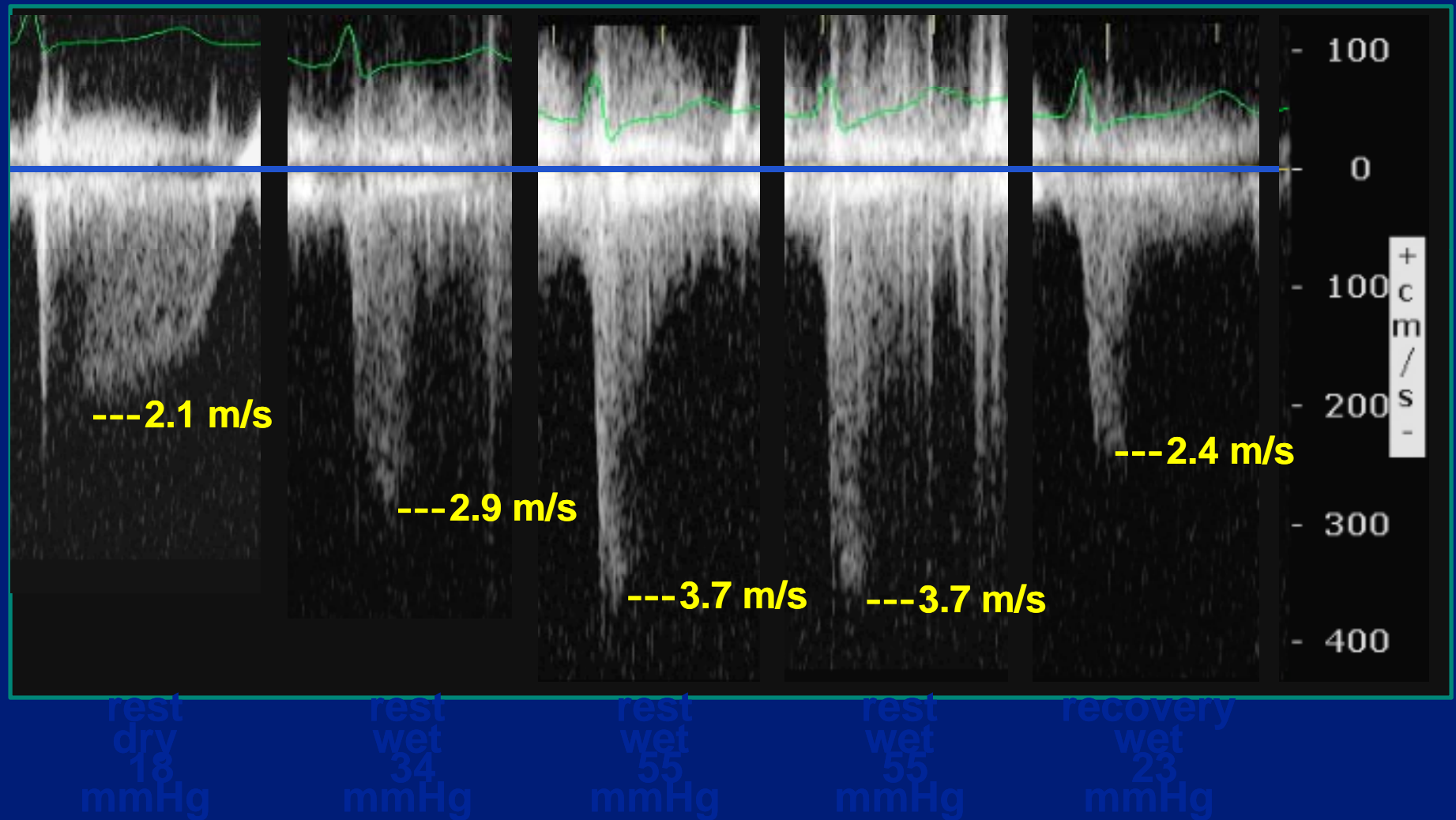
Results

- SIPE subject had dramatic rise in RVSP compared to controls: 32.6mmHG vs 62mmHg
- SIPE subject lost respiratory variation in IVC diameter during exertion
- E/e' consistently elevated in SIPE subject compared to controls
- MRI in SIPE subject showed heterogeneous increase in lung water
- Comet tails not useful

Tricuspid Regurgitation

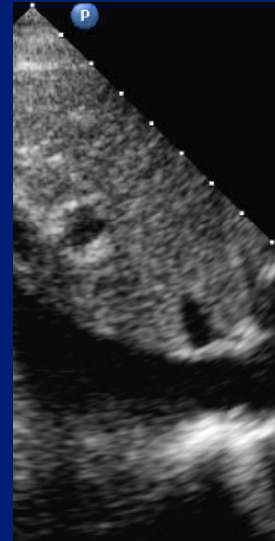
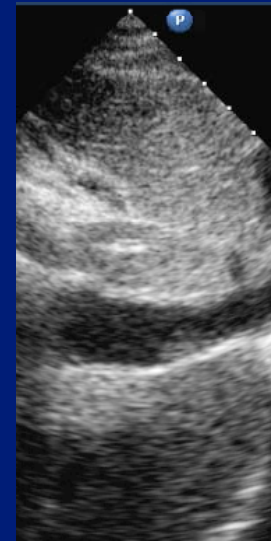
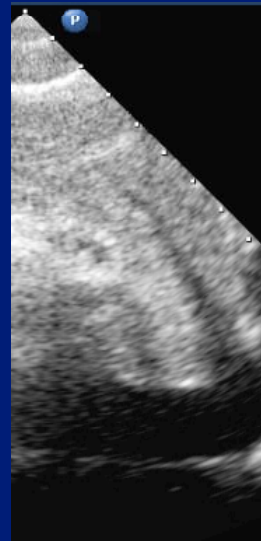
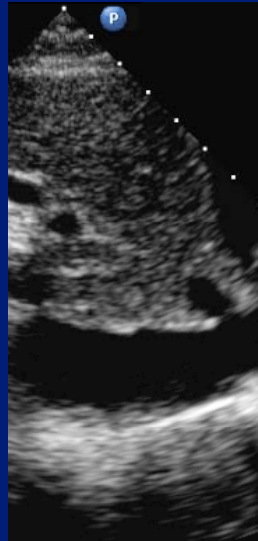
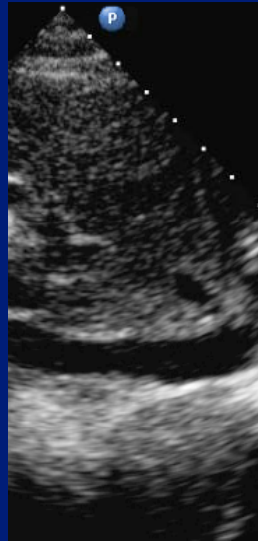


Increase in TR Velocity

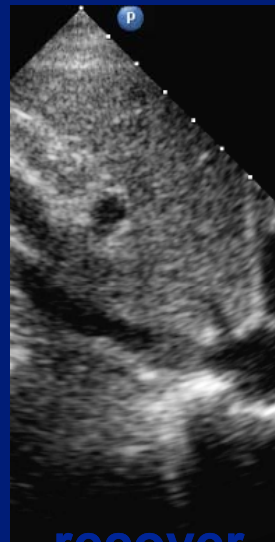
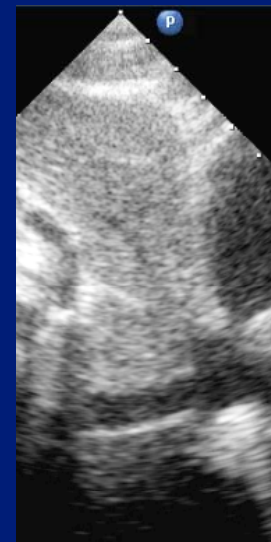
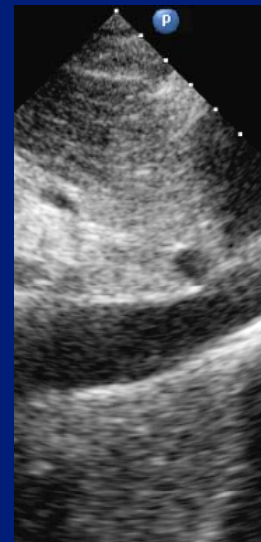
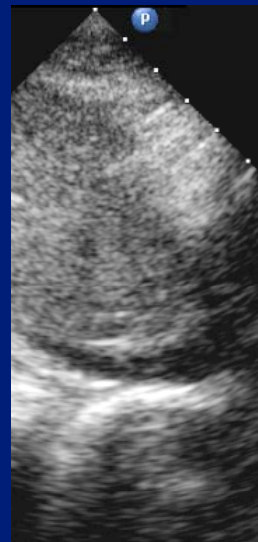


IVC Loss of Respiratory Variation

Expiration



Inspiration



rest
dry

rest
wet

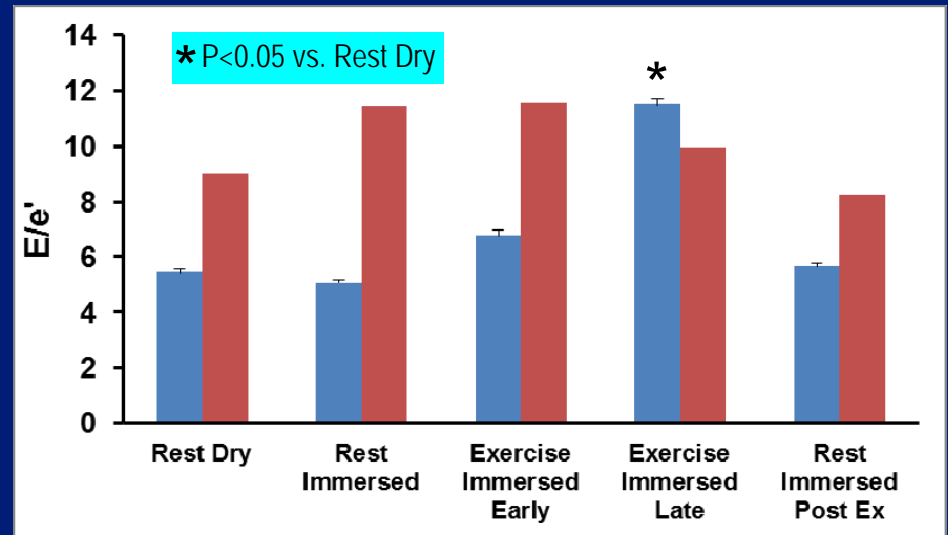
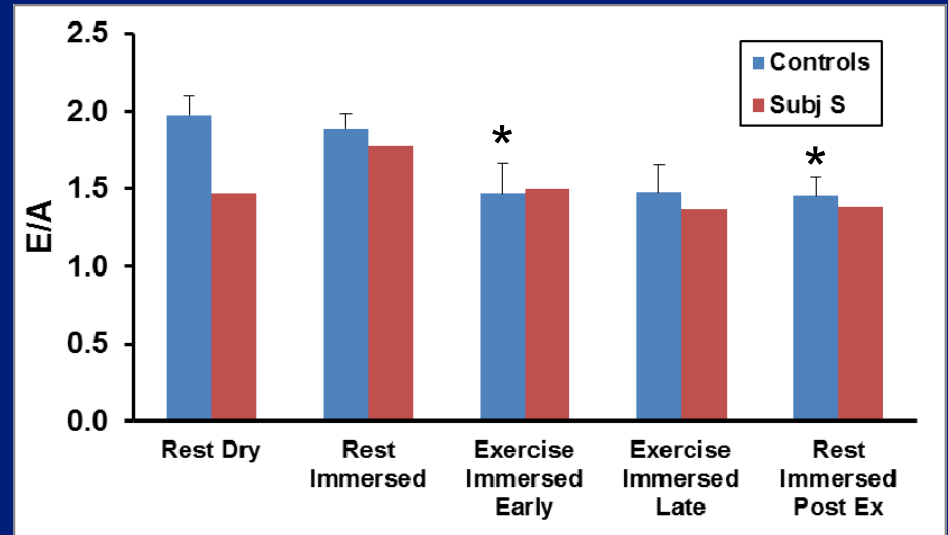
min
wet

max
wet

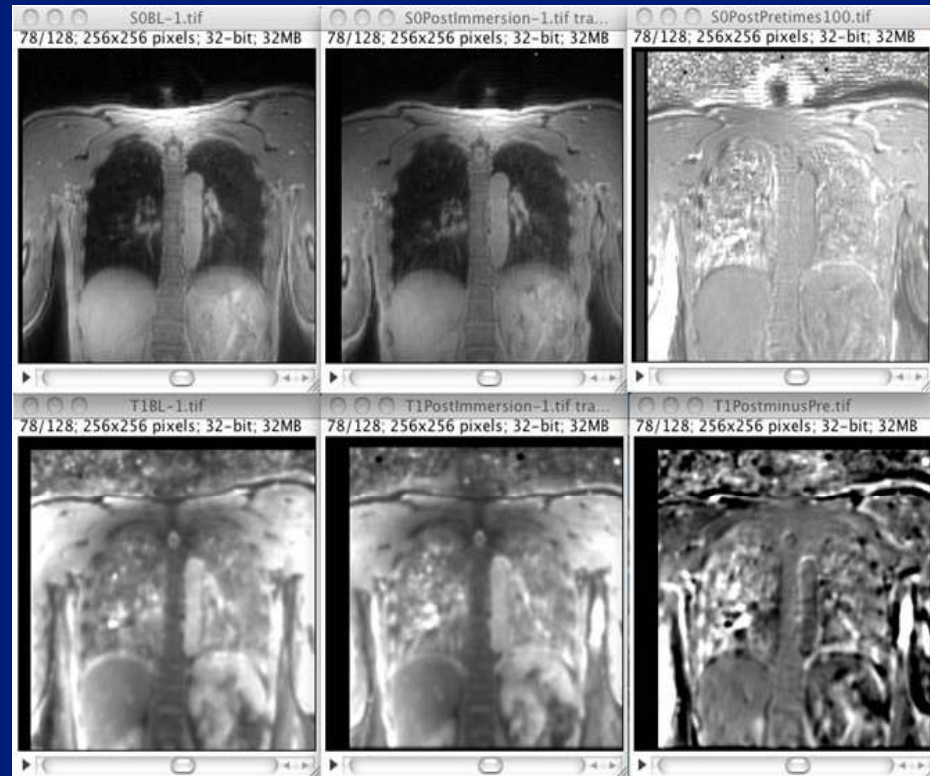
recover
y
wet

Results

- 142 subjects screened, 31 studied: 20 in this analysis
- M=12, F=8
- Mean age 25.9 y (range 19-42)
- Mean O_2 cons. 2.3 ± 0.8 L/min
- Water temp 20.5°C



Results



Conclusions

- We have demonstrated the feasibility of performing quantitative echocardiography during immersed exercise. Changes in E/A and E/e' during immersed exercise suggest impaired diastolic filling even in controls
- Preliminary results suggest that SIPE-susceptible individuals may be identifiable using this technique. The SIPE susceptible individual showed an increase in RVSP and E/e' with immersion, consistent with impairment of diastolic filling
- Intrapulmonary comet-tails may be spurious and an unreliable indicator of mild pulmonary edema
- Preliminary results from pulmonary MRI are consistent with mild pulmonary edema after 40 minutes of exercise in cold water in a SIPE-susceptible individual

Acknowledgment

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