

Microbubble Detection Following Repeated Exercise

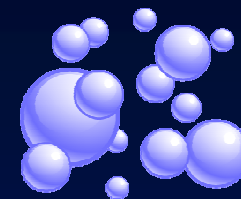


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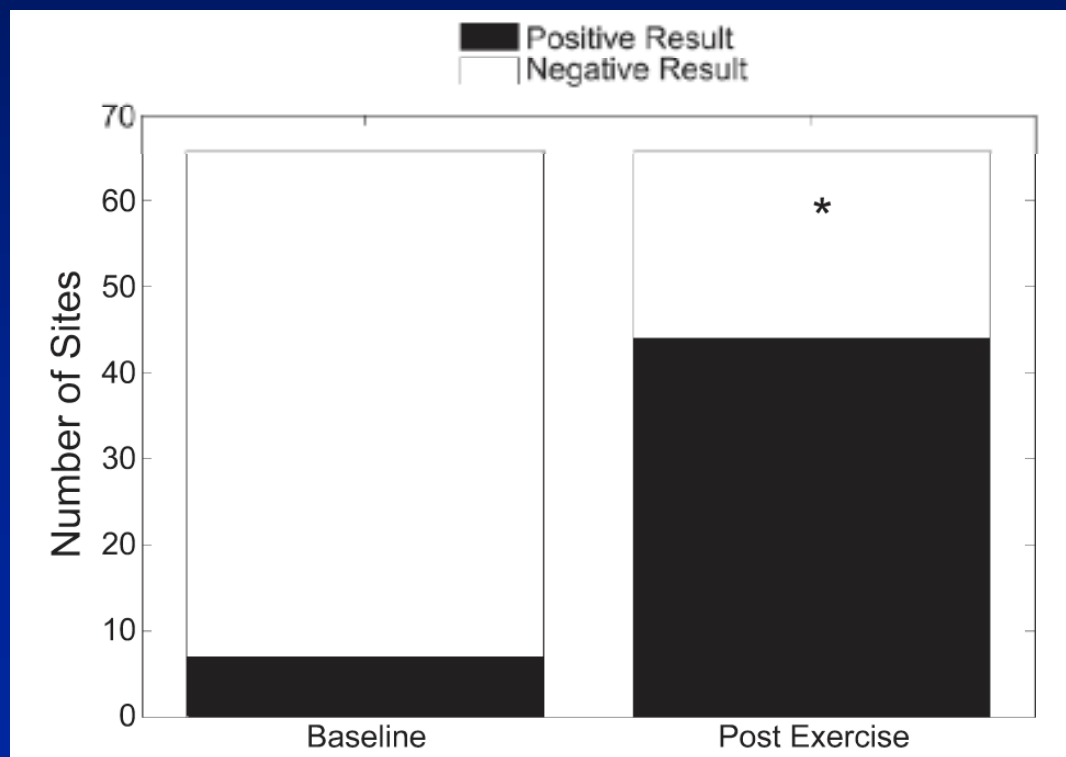
²Creare, Inc., Hanover NH

Funding provided by the ONR

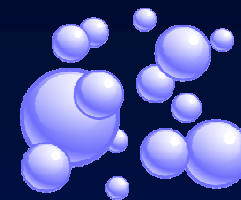


Bubble Detection-*Background*

We previously established that exercise produces microbubbles in working tissue beds

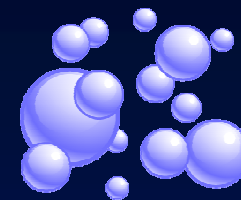


From Wilbur et al. *Journal of Applied Physiology* 108 240-244, 2010.



Bubble Detection-*Background*

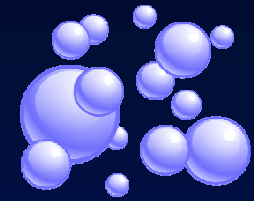
- **Previous study only examined one bout of exercise**
- **Not known if findings would persist with repeat exercise bouts**
- **Habituation (decrease) in effect might suggest biochemical or other modifications of microbubble formation**
- **No decrease suggests mainly a mechanical effect**
- **Not known if particular sites more likely to produce bubbles**



Bubble Detection-Questions

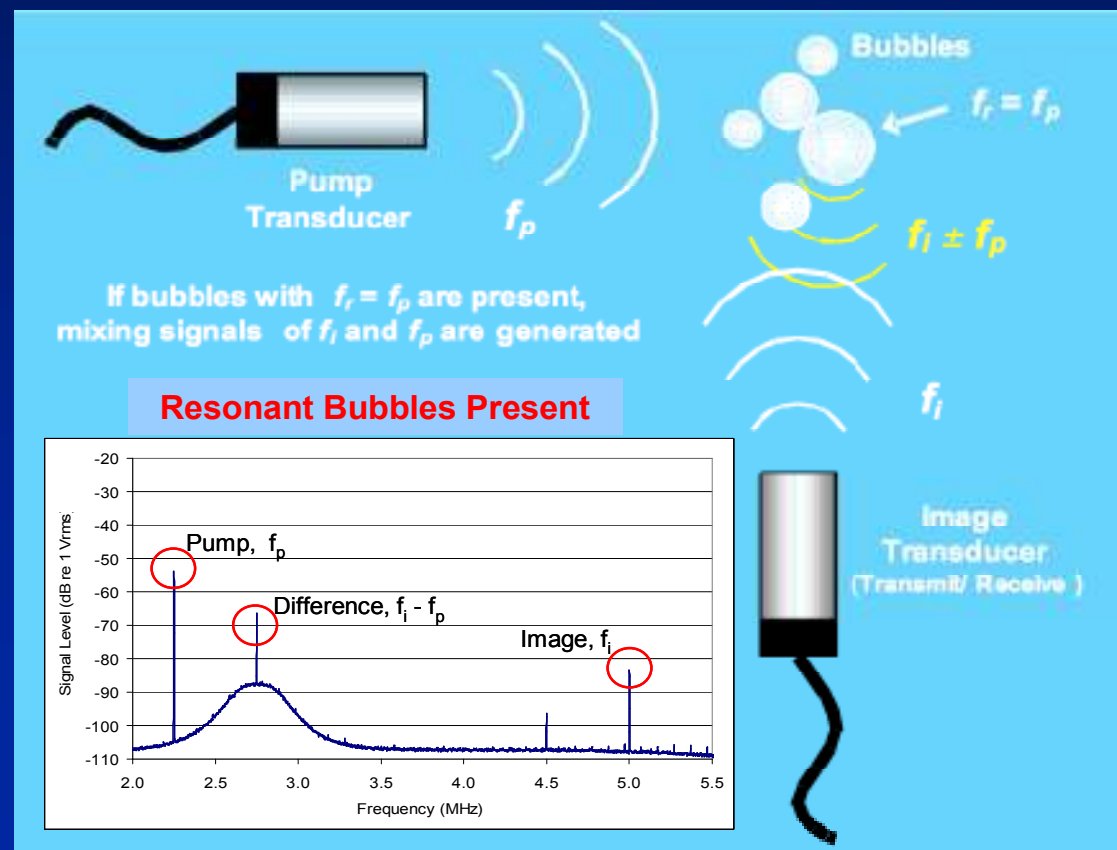
Will a repeated exercise bout increase, decrease, or have no effect on detected bubble signals?

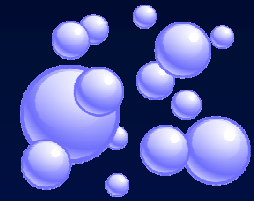
Are there particular sites which produce more bubbles than others?



Bubble Detection-*Methods*

- **Dual Frequency Ultrasound**
 - Based on non-linear behavior of resonating bubbles
 - Can detect and size stationary microbubbles in tissue





Bubble Detection-*Methods*

- 8 normal human subjects rode a bicycle for 30 minutes at 80% of age-predicted maximal heart rate
 - *Age = 36.8 ± 9.7 years*
- Measurements made at 3 time points : baseline, post-exercise 1, post-exercise 2

Study Protocol



= Rest



= Cycle Ergometry; 80% age-predicted HR_{max}

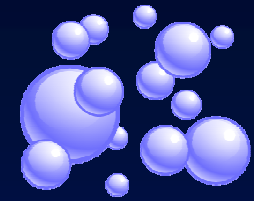
Data Collection Points:

Baseline 1

Post Exercise 2

Post Exercise 2



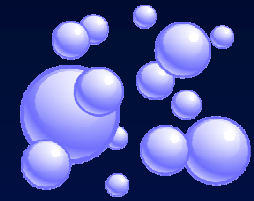


Bubble Detection-*Methods*

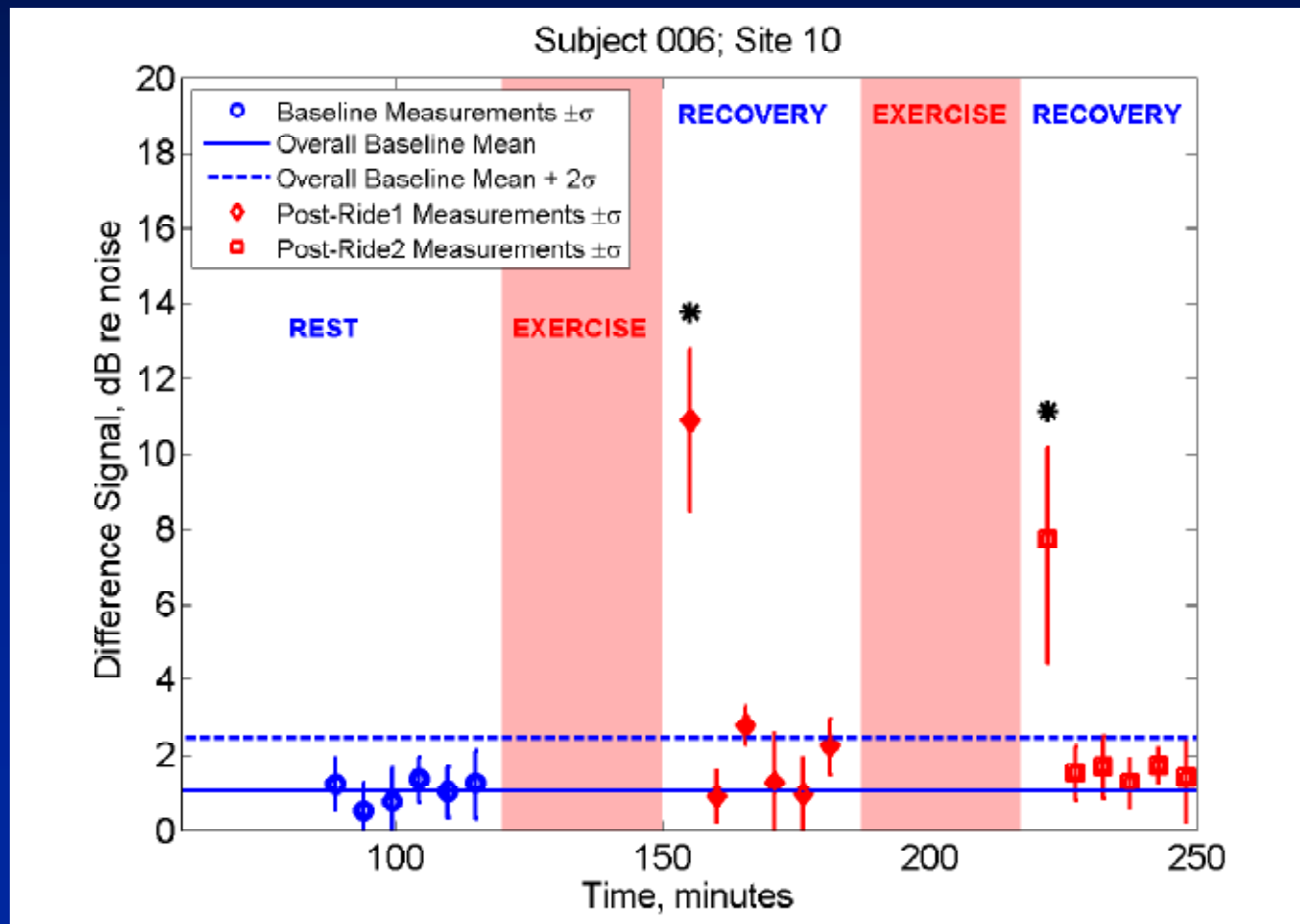
Measured microbubbles at 11 sites on quadriceps, tibialis anterior and gastrocnemius

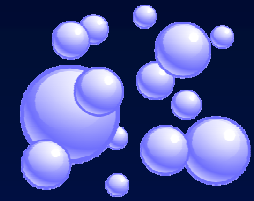


Bubble Detection-Results



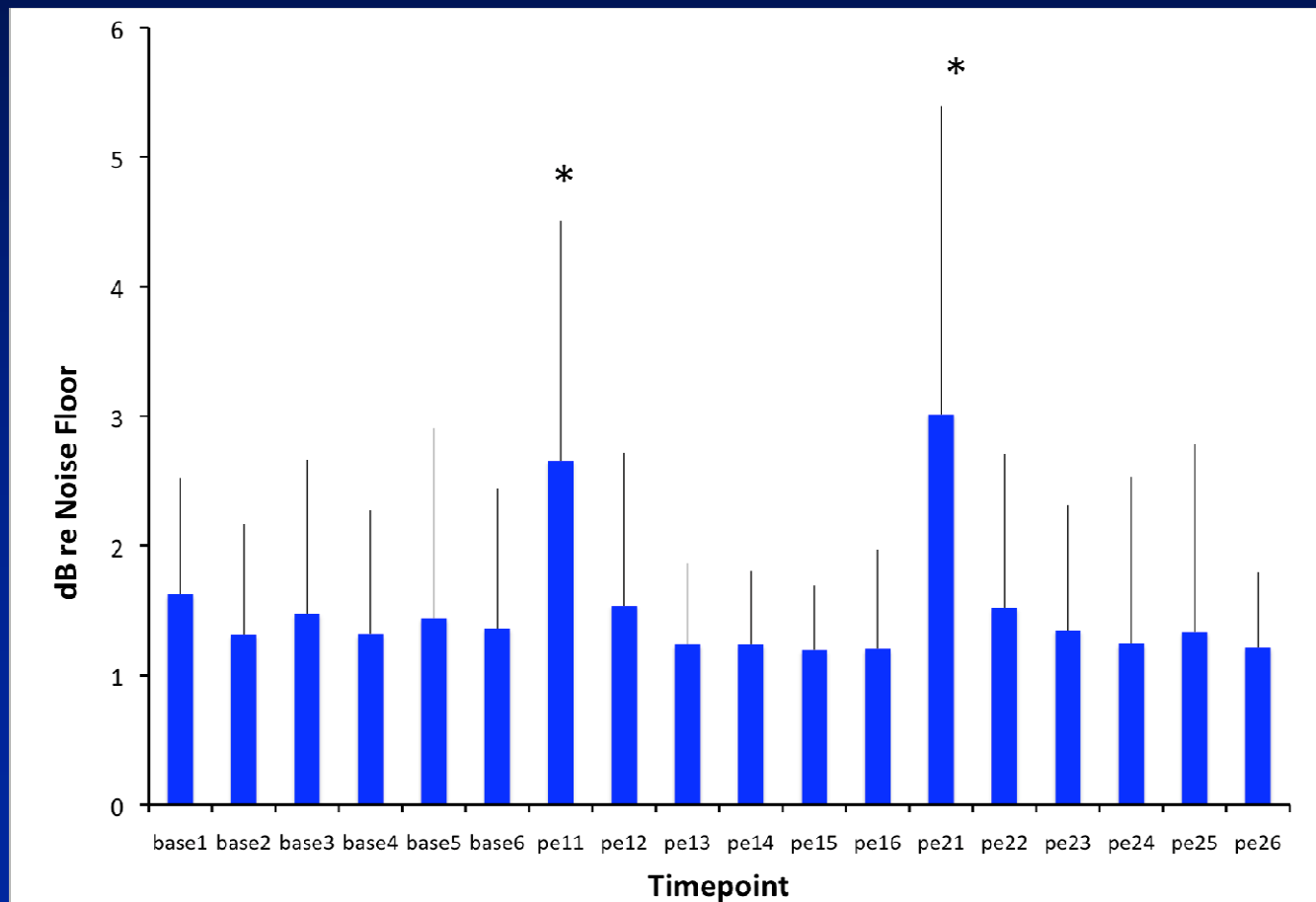
Example of microbubble detection

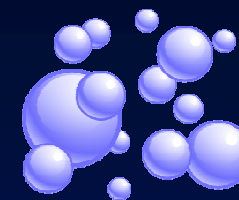




Bubble Detection-*Results*

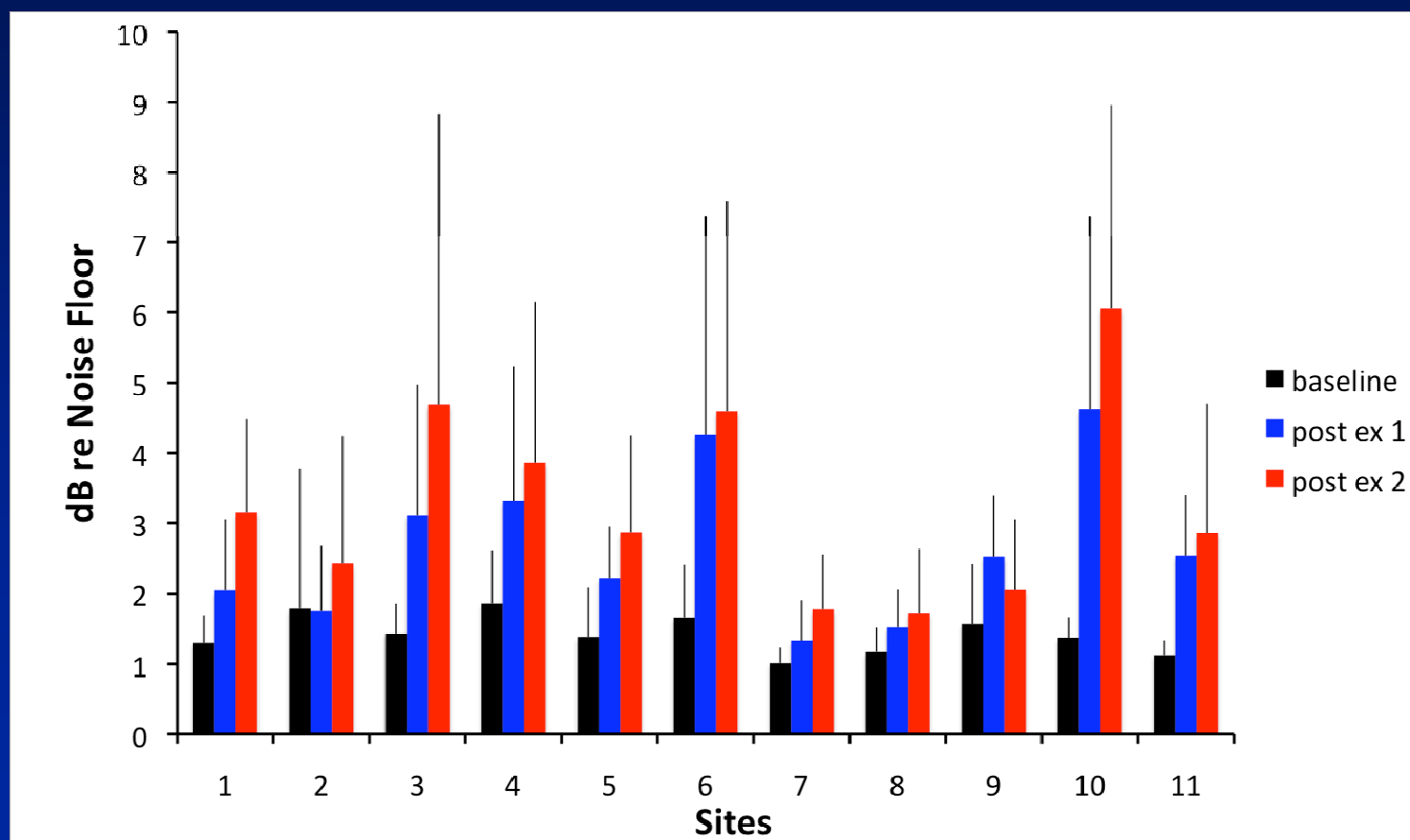
Significant change post-exercise; all subjects, all sites



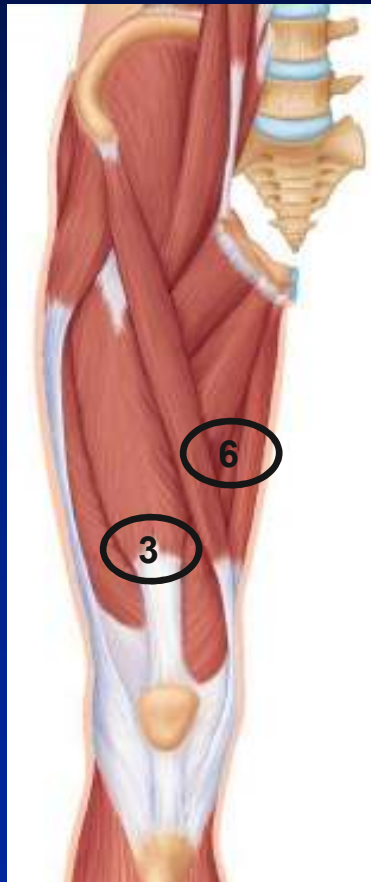
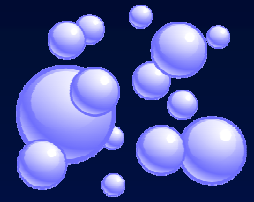


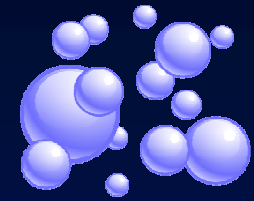
Bubble Detection-*Results*

Sites 3, 6, and 10 show the highest production of microbubbles



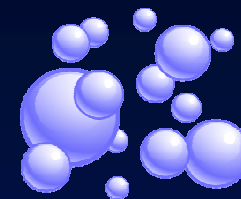
Bubble Detection-*Results*





Bubble Detection-*Conclusions*

- **Exercise causes a transient increase (~5min) in microbubbles in the working tissue following a repeated exercise bout**
- **Microbubble formation did not diminish with successive work bouts**
- **Suggests that bubble formation may be primarily a physical process on the time scale examined here, although more work needed to establish this definitively**
- **Certain tissue beds seem to bubble more than others**



Bubble Detection-*Next steps*

- **Need to assess with decompression episode following exercise bout**
- **Determine location of microbubbles – tissue, bloodstream, joint cavity?**
- **Determine microbubble constituents**
- **Longer duration between work bouts**