PROTEUS®

**HSS Research
(Aug 3rd, 2020)**
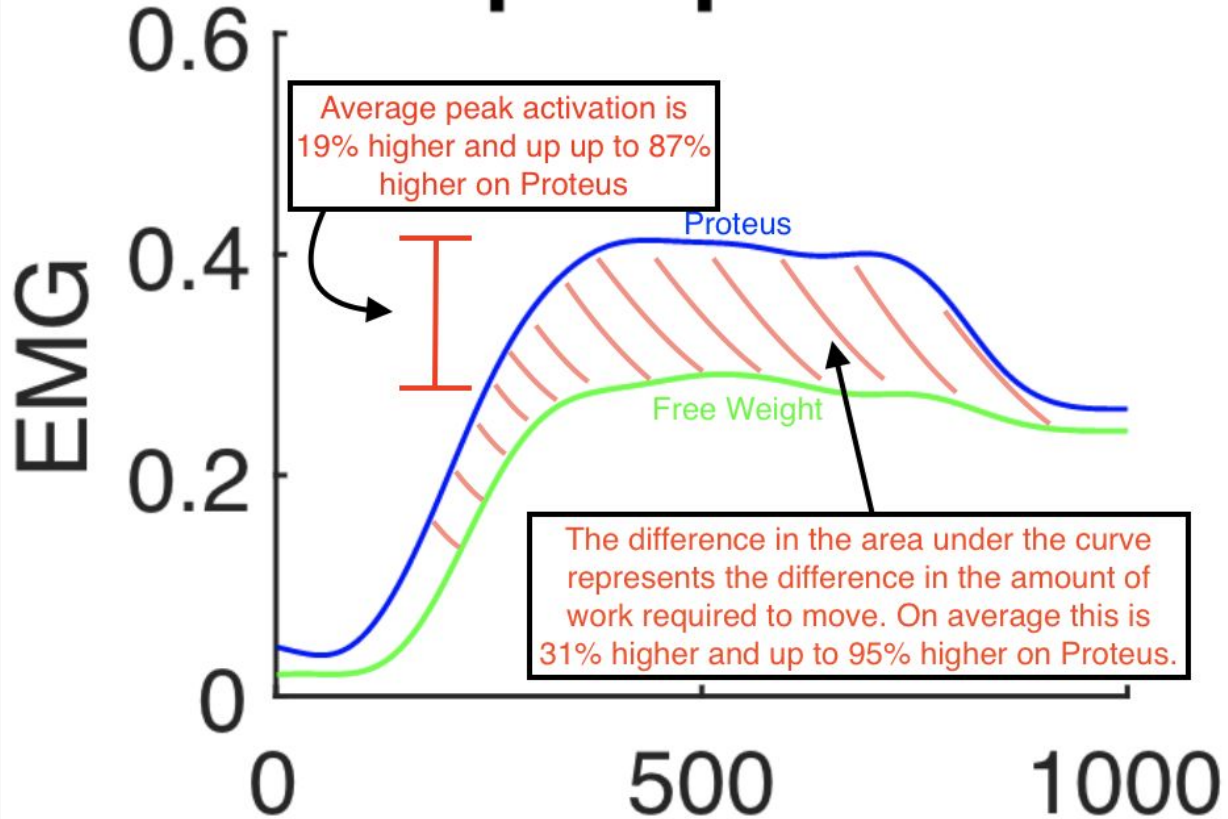
HSS Research

METHODS

- EMG fine wire and surface EMG recorded on 3 different exercise conditions:
    - 8 lbs on Proteus
    - 8 lbs on Free Weights
    - 12 lbs on Cable
- 10 subjects performed 7 reps of each movement on each modality with the first and last rep dropped for a total of 5 reps per movement analyzed (50 reps total per exercise per machine)

- Some exercises (marked by x) not tested on free weights due to difficulty with EMG recording and testing position.

- Hypothesis: Peak activation and activation duration are higher on Proteus. Would indicate greater maximum effort and work required and therefore a more efficient and effective workout.

	Movements Tested		
	Proteus	**Pulley**	**Free Weight**
Abduction	x	x	x
Adduction	x	x	
Flexion	x	x	x
Extension	x	x	
Scaption	x	x	x
Scaption Ext	x	x	
ER (0 Deg)	x	x	x
IR (0 Deg)	x	x	
ER 90 Deg	x	x	x
IR 90 Deg	x	x	
PNF Flexion	x	x	x
PNF Extension	x	x	

Supraspinatus

Average peak activation is 19% higher and up up to 87% higher on Proteus

Proteus

Free Weight

The difference in the area under the curve represents the difference in the amount of work required to move. On average this is 31% higher and up to 95% higher on Proteus.

EMG

0.6
0.4
0.2
0

0   500   1000

Summary of Findings

An evaluation of findings of Proteus vs. Free Weights across all muscles of interest:

Summary: For 6 different shoulder exercises, compared to free weights, Proteus produces an average of 19% greater peak muscle activation and requires 31% greater overall work output for primary movers muscles

Peak Activation[2] High: 87% higher on Proteus (posterior deltoid during D2 Flexion)

Peak Activation Low: 5% higher on Free Weight (infraspinatus during ER at 0 deg)

Peak Activation Average: **19.36% higher on Proteus**

Activation Duration High: 94.85% higher on Proteus (posterior deltoid during D2 Flexion)

Activation Duration Low: 7.77% higher on Free Weights (infraspinatus during ER at 0 Deg)

Activation Duration Average: 31.49% higher on Proteus

*excludes ER data
[1]Primary Movers = main muscles responsible for an action
[2]Peak Activation = the highest amount of measured activation signal in microvolts across the movement)
[3]Activation duration = activation amount times the time activated which would indicate the total amount of work required to complete the movement.)

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Implications

Implications:

1. When FORCE production improvement is desired, Proteus is a more effective tool than free weights due to the higher muscle activation.
2. When endurance and conditioning improvement is desired, Proteus is a more effective tool than free weights (shoulder, 8 lbs) due to the increased metabolic demand of higher muscle activation.
3. When neuromuscular stimulus is desired, as would be the case when improving motor learning and proprioception, Proteus is a more effective tool than free weights due to higher levels of muscle activation.
4. When improved arthrokinematics is desired, Proteus is the better choice over free weights has RTC activation is higher which lead to improved joint centration.

*excludes ER data
[1]Primary Movers = main muscles responsible for an action)
[2]Peak Activation = the highest amount of measured activation signal in microvolts across the movement)
[3]Activation duration = activation amount times the time activated which would indicate the total amount of work required to complete the movement.)

Highlights

Proteus is the winner!
For the movements of **Flexion, Abduction, Scaption, and PNF D2 Flexion** Proteus shows superior peak muscle activation and activation duration both in the global primary mover and the RTC muscle.

This makes Proteus the ideal choice for rehab as well as training where high efforts are desired with high activation of the RTC in order to keep the joint centrated during movement

Free Weights the winner for ER
For **External Rotation** at both 0 and 90 degrees, free weight showed to be superior in activation of the infraspinatus. This is likely due to the effects of gravity and the position of the arm in the testing position resulting in an increased load in the long position of the muscle (ER 90 deg) and short position of the muscle (ER 0 deg).

However, the **Supraspinatus** was more active in ER at 90 Deg on Proteus. Rehab and training professionals should consider this when selecting exercises.

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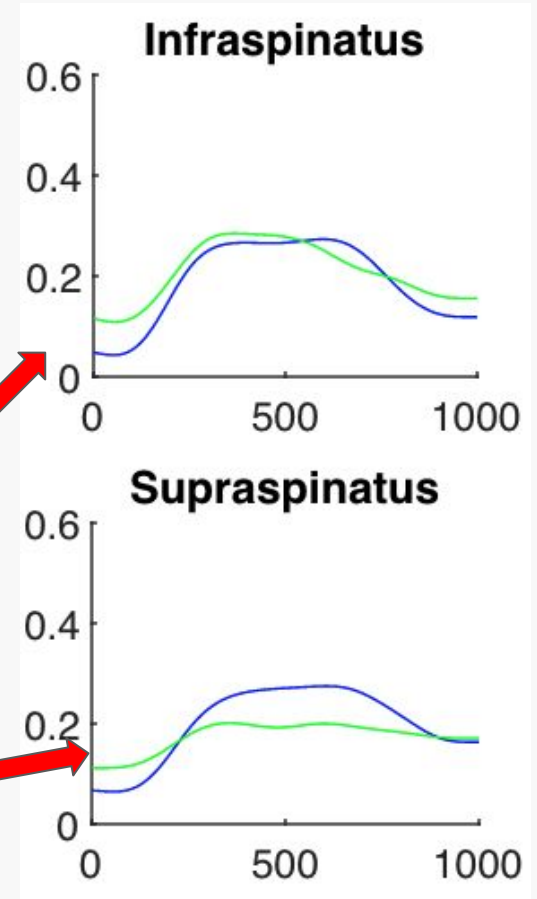
Proteus vs Free Weights: <u>Abduction</u>

<u>Peak Activation in Primary Movers</u>

- Anterior Deltoid: 13%*
- Middle Deltoid: 7%
- Posterior Deltoid: **41%***
- Supraspinatus: 37%*

<u>Activation Duration in Primary Movers</u>

- Anterior Deltoid: 32%*
- Middle Deltoid: 32%*
- Posterior Deltoid: 48%*
- Supraspinatus: **52%***

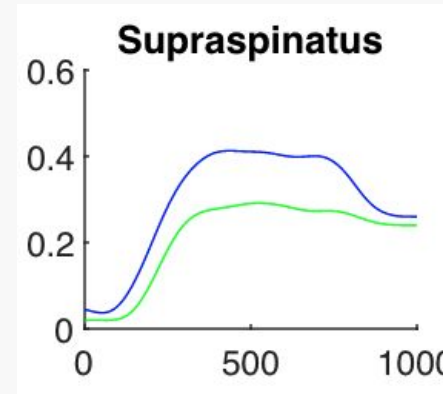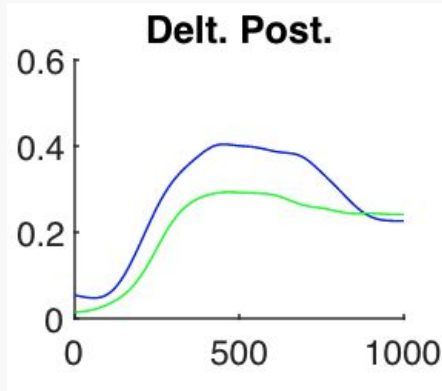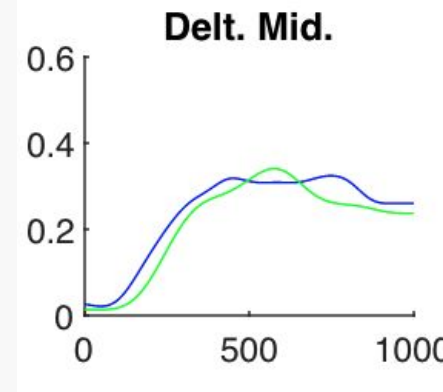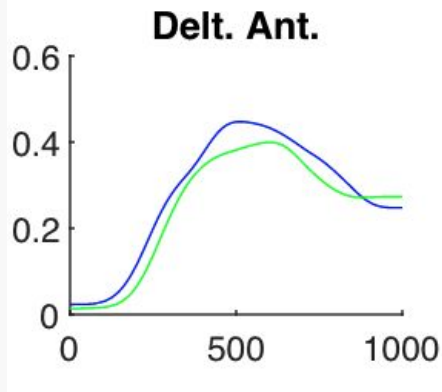*indicates statistically significant*

<u>Overall Statements:</u>

Peak activation as high as <u>41%</u> greater

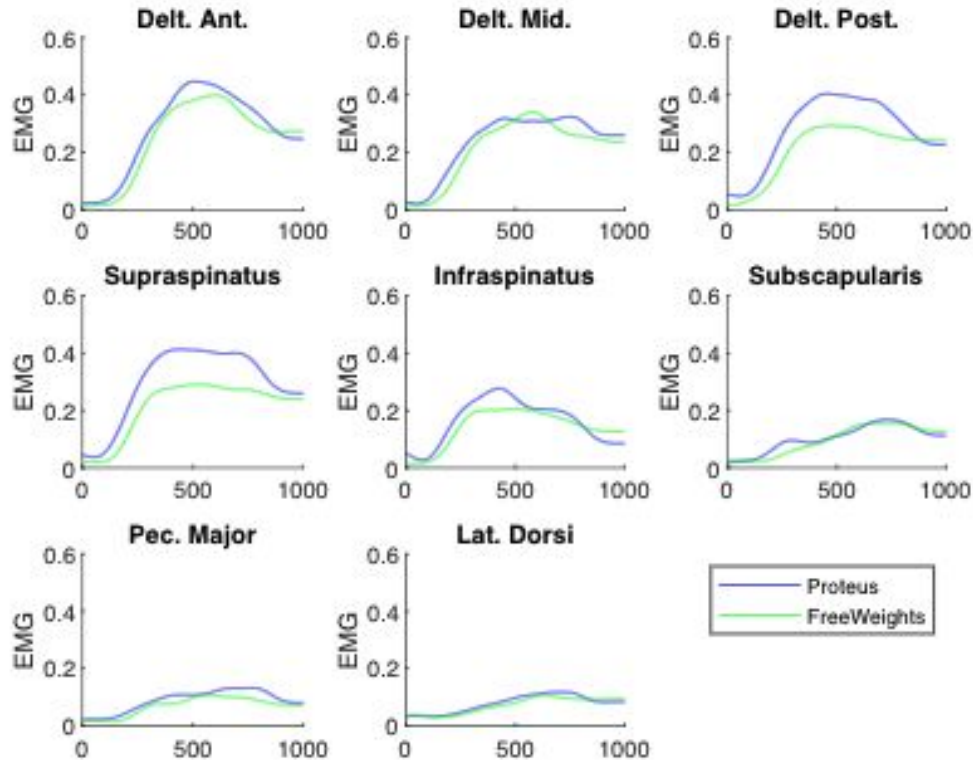Average Peak Activation Difference: <u>24%</u> Higher

Activation duration as high as <u>52%</u> greater

Average Activation Duration Difference: <u>42%</u> Higher

Proteus vs Free Weights:
<u>Abduction</u>

Peak: **13%**>

Duration: **32%**>

Peak: **7%**>

Duration: **32%**>

Peak: <mark>**41%**></mark>

Duration: **48%**>

Peak: **37%**>

Duration: <mark>**52%**></mark>

Proteus vs Free Weights:
Abduction
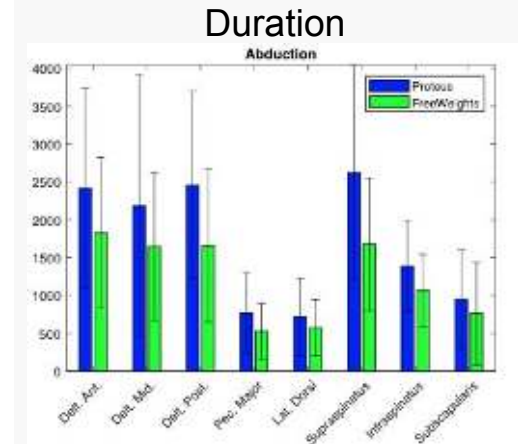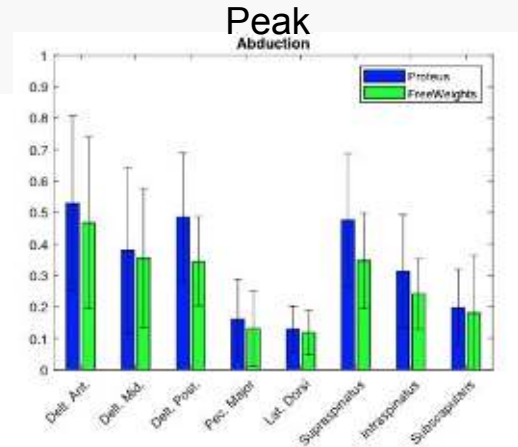
Proteus vs Free Weights:
<u>Abduction</u>

What does this mean in application?

RTC engagement is important with performing exercises with good joint centration and stability in the GH joint. This research indicates greater activation of the Supraspinatus as well as other RTC musculature during abduction.

There is also indication of greater activation of the primary movers. Overall this would indicated Proteus as a superior choice for both primary movers and joint stabilizers for concentric abduction, a difficult exercise to perform with both good muscle force and stabilization.

Proteus vs Free Weights:
<u>**Flexion**</u>

<u>Peak Activation in Primary Movers</u>

- Anterior Deltoid: 5%
- Supraspinatus: **57%***

<u>Activation Duration in Primary Movers</u>

- Anterior Deltoid: 25%*
- Supraspinatus: **69%***

indicates statistically significant
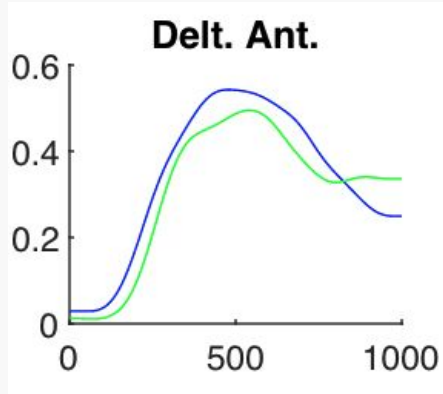
<u>Overall Statements:</u>

Peak activation as high as <u>57%</u> greater

Average Peak Activation Difference: <u>31%</u> Higher
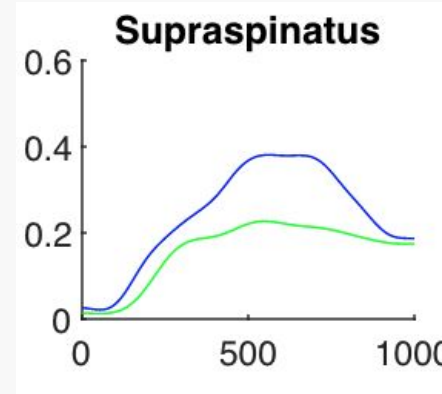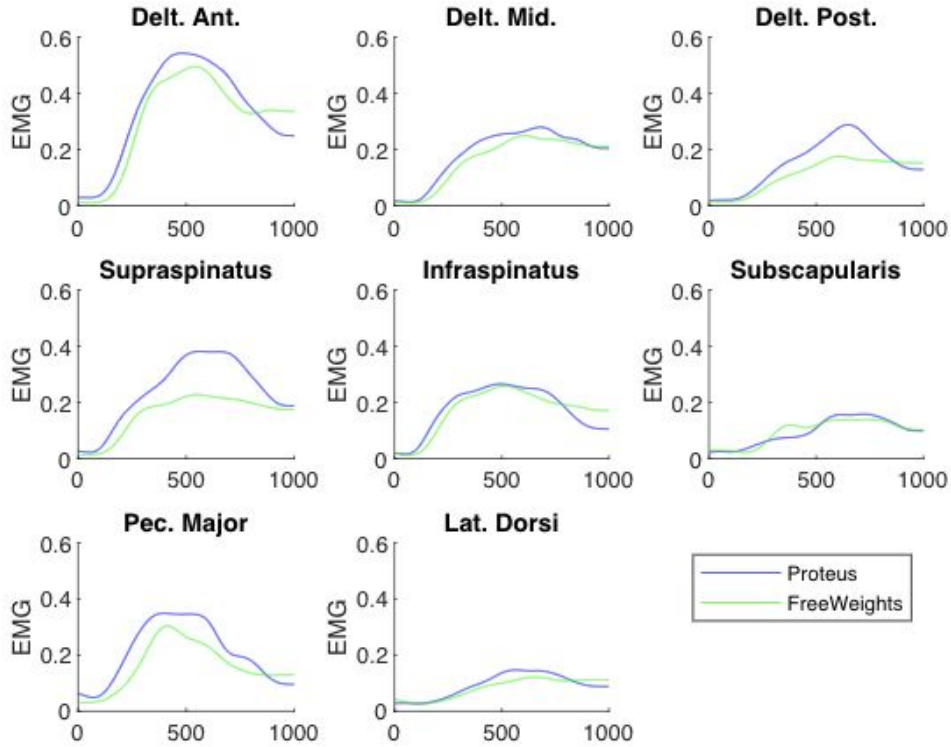
Activation duration as high as <u>69%</u> greater

Average Activation Duration Difference: <u>47%</u> Higher

Proteus vs Free Weights:
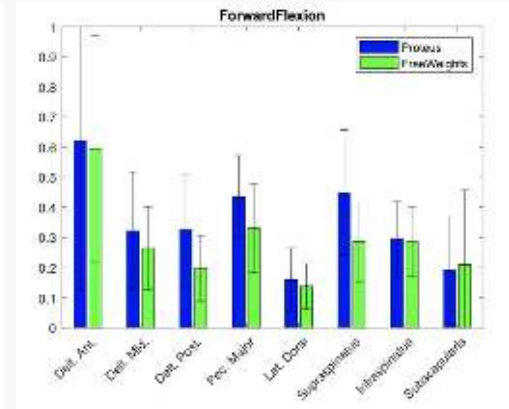## <u>Flexion</u>

Peak: **5%**>

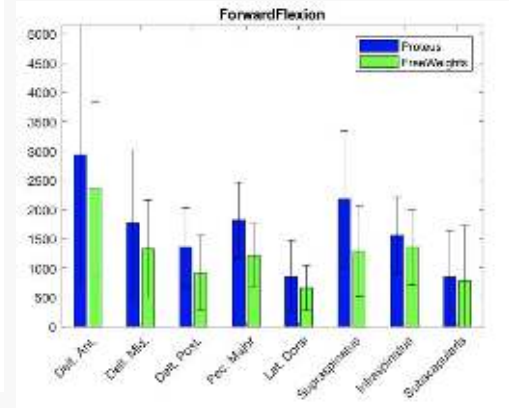Duration: 25**%**>

Peak: **57%**>

Duration: **69%**>

Proteus vs Free Weights:
__Flexion__

Peak

Duration

Proteus vs Free Weights:
Scaption

Peak Activation in Primary Movers

- Anterior Deltoid: 10%
- Supraspinatus: **20%***

Activation Duration in Primary Movers

- Anterior Deltoid: 26%*
- Supraspinatus: **42%***

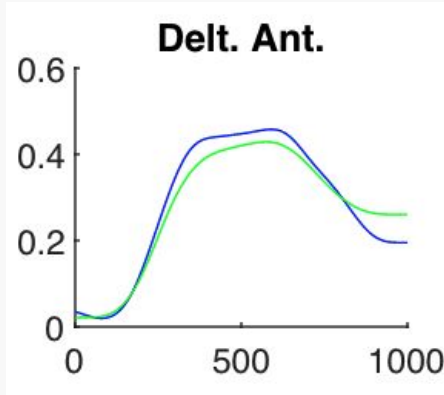*indicates statistically significant*

Overall Statements:

Peak activation as high as 20% greater

Average Peak Activation Difference: 15% higher

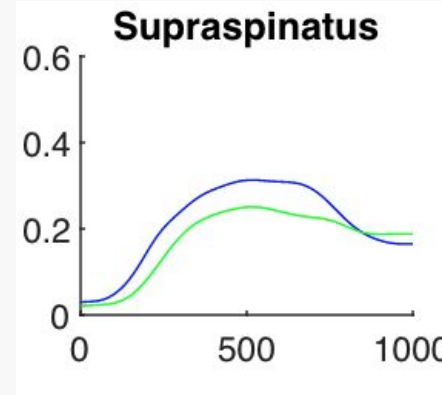Activation duration as high as 42% greater

Average Activation Duration difference: 34% higher

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Proteus vs Free Weights:
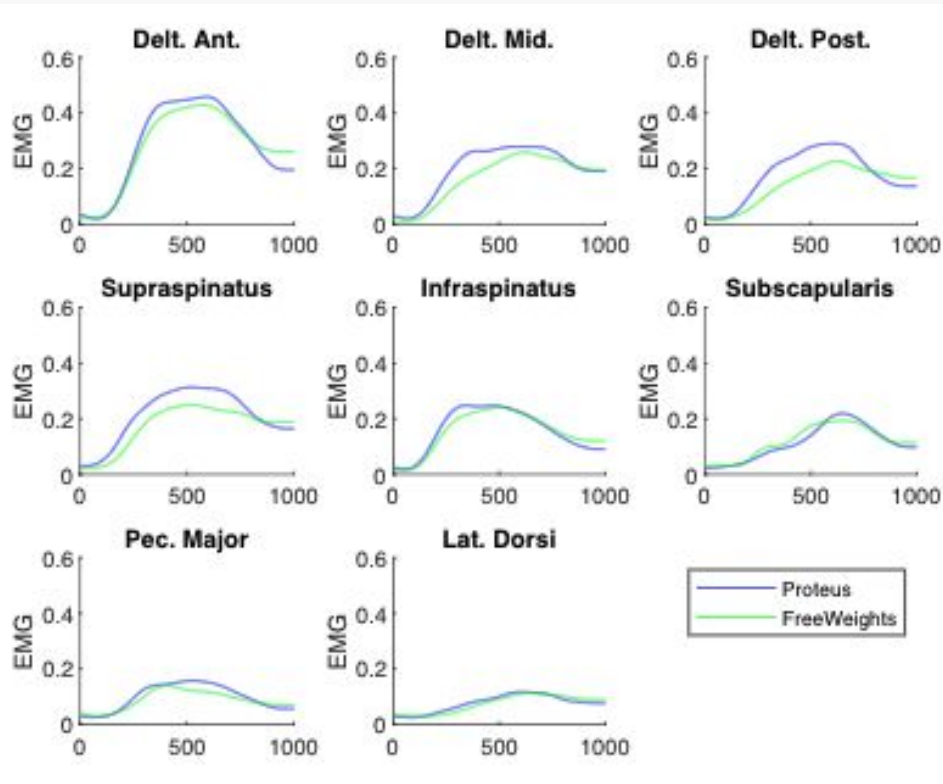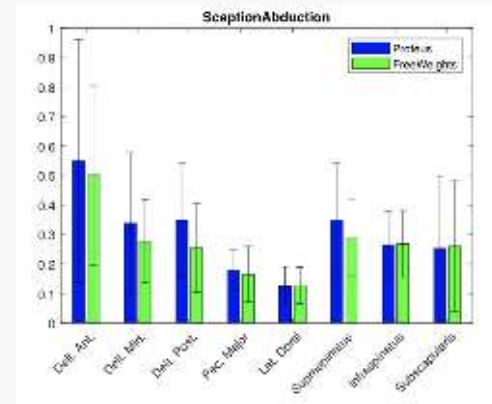## <u>Scaption</u>

Peak: **10%**>
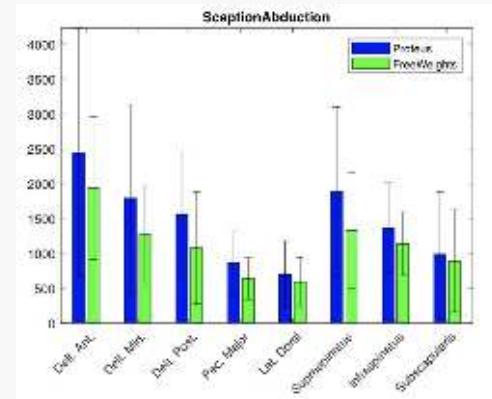
Duration: **26%**>

Peak: **20%**>

Duration: **42%**>

Proteus vs Free Weights:
<u>Scaption</u>

Peak

Duration

Proteus vs Free Weights:
PNF D2 Flexion

Peak Activation in Primary Movers

- Anterior Deltoid: -4%
- Middle Deltoid: 23%*
- Posterior Deltoid: **87%***
- Supraspinatus: 26%
- Infraspinatus: 10%

Activation Duration in Primary Movers

- Anterior Deltoid: 13%
- Middle Deltoid: 44%*
- Posterior Deltoid: **95%***
- Supraspinatus: 48%*
- Infraspinatus: 26%*

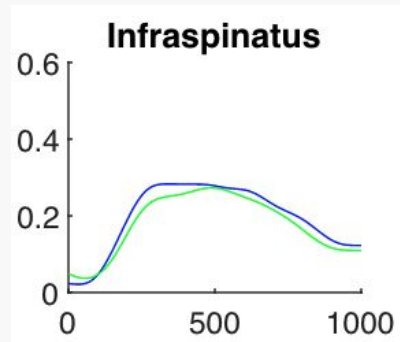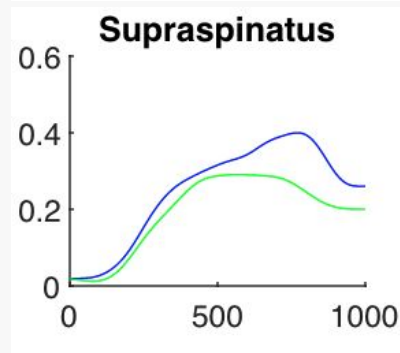*indicates statistically significant*
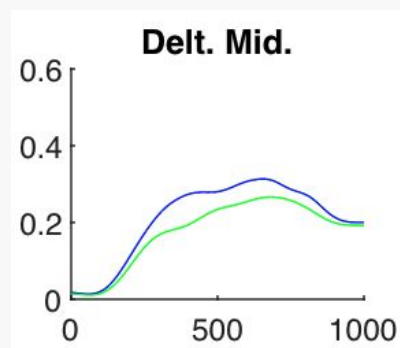
Overall Statements:

Peak activation as high as 87% greater

Average Peak Activation Difference: 24% higher

Activation duration as high as 95% greater

Average Activation Duration Difference: 45% Higher

Proteus vs Free Weights: PNF D2 Flexion

Delt. Ant.

Peak: **4%**<

Duration: **13%**>

Delt. Post.

Peak: **87%**>

Duration: **95%**>

Delt. Mid.

Peak: **23%**>

Duration: **44%**>

Supraspinatus

Peak: **26%**>

Duration: **48%**>

Infraspinatus

Peak: **10%**>
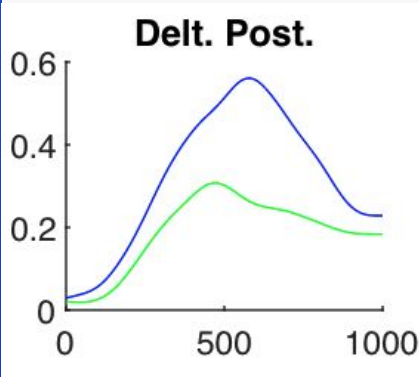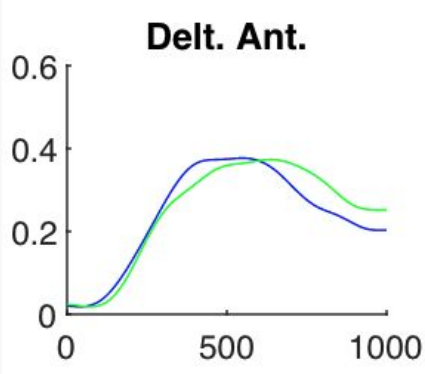
Duration: **26%**>
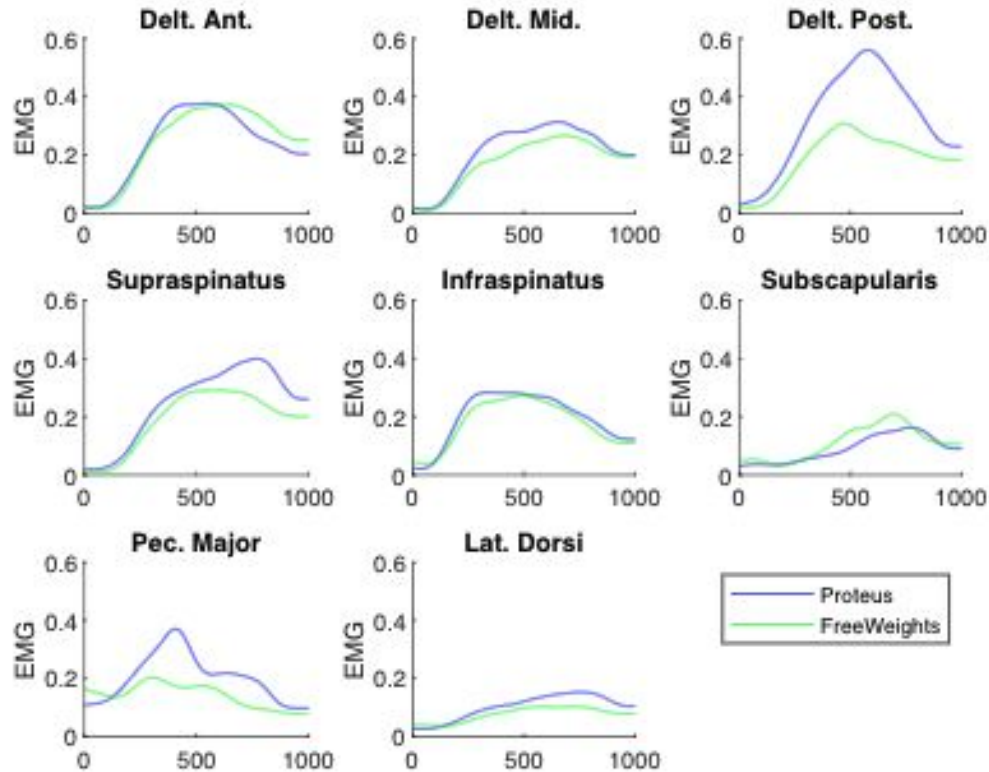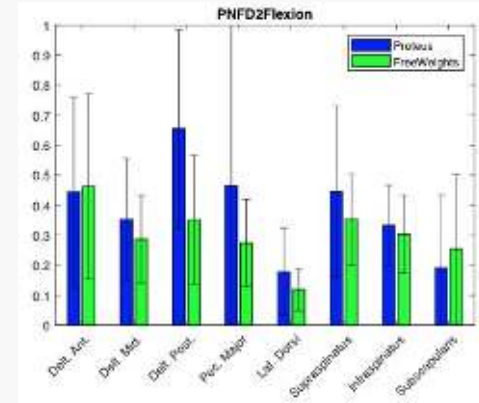
Proteus vs Free Weights:
<u>PNF D2 Flexion</u>

Other Questions

Peak activation occurrence in ROM - All Exercises.

- Where in the ROM did activation peak for specific muscles and how does this differ than traditional resistance?

This can affect the utility of when it is best to do certain movements on Proteus vs the other modalities if the timing of activation is more desirable on one vs the other.

conclusions that are specific. That is, given what we know about these results, what exercises would you list as MUST HAVE exercises to do on Proteus. And further, which are the best exercises to target post deltoid (obvi pnf flexion on proteus), supra,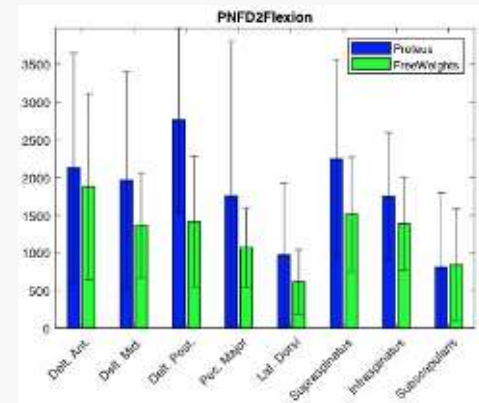 and any others which you think are obvious. If we can roll this up into a nice summary, we can turn this into some compelling marketable content and educational material.

Proteus is the best performing tool for rotator cuff strengthening (in training and rehab).	Problem: not necessarily the case (doesn't do eccentrics, which are important depending on goals)
In early stage rehab, Proteus is the ideal tool for rotator cuff strengthing	
Supraspinatus activation is higher in Abduction, Scaption, PNF D2 Flexion, and Flexion.	

Proteus vs Free Weights Summary:

Overall across all primary movers

(Primary Movers = main muscles responsible for an action)

Peak Activation = **19.36% higher on average;** on Proteus (Range is 5%-87% higher*)

(Peak Activation = the highest amount of measured activation signal in microvolts across the movement)

Activation Duration = **31.49% higher** on Proteus (Range is 13%-95% higher*)

(Activation duration = activation amount times the time activated which would indicate the total amount of work required to complete the movement.)

Statement: For 6 different shoulder exercises, Proteus produces an average of 19% great peak muscle activation and requires 31% greater overall work output than free weights to achieve the same concentric movement

Implications: When choosing an exercise modality, if the goal is muscle activation, as would be the case for improving power production, providing a higher metabolic demand to the user, or a greater neuromuscular stimulus, Proteus is a superior choice for most movements tested vs free weights.

excludes ER data

Suopraspinatus

Peak muscle activation is up to 87% higher on Proteus. (Shown here: 31% higher for the supraspinatus muscle during a shoulder exercise

Proteus

Free Weight

The difference in the area under the curve represents the difference in the amount of work required by a user to move through a single repetition. With Proteus, this area difference is up to 95% higher on Proteus versus a free weight.

Time scale, normalized across a 1 second repetition