



WEBINAR SERIES

Title: Fast-Twitch vs. Slow-Twitch Muscle Fiber Training in Individuals with ABI

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Disclosures

- Jamie Young, PT, DPT– Nothing to disclose

Following This Session:

- You should be able to:
 - Identify the differences between fast twitch and slow twitch muscle fibers
 - Identify how fast vs. slow twitch muscle fiber training affects functional gains
 - Judge which strategy may be optimal in clinical cases based on case description and goals
 - Identify ways to implement training strategies into the clinic

How Familiar Are You?

**Difference
Between
Fast vs.
Slow-
Twitch**

**Which is
Recruited
for Different
Activities**

**Can We
Vary
Training To
Affect
Functional**



What's the Difference




Fast Twitch Muscle Fibers

- ▶ Known in research as type II muscle fibers
- ▶ Typically thought of powerful bursts of movement
- ▶ In our population: function like crossing streets, getting to the restroom on time, standing from a low chair

Slow Twitch Muscle Fibers

- ▶ Known in research as type I muscle fibers
- ▶ Typically thought of as endurance fibers/active in endurance activities
- ▶ In our population: function like walking around for grocery shopping, community outings, going to the mall, etc.



Fast-Twitch Training: Muscular Power (Type II)

Power Training in Neuro Healthy Population



- ▶ Max muscle output in a given time frame. Frame or movement (Esco¹)

https://www.youtube.com/watch?v=Qu04_BtZjw4

ACSM Guidelines

% 1 RM	Reps	Sets	Rest
0-60	3-6	2-3	1-3 mins

Muscle Power in People with vs. without CVA

► Stavric & McNair⁸

- Optimizing muscle power after stroke: A cross-sectional study
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- ## ► Compared lower extremity power in people with vs. without stroke, and involved vs. uninvolved limbs
- Unilateral stroke >6 months ago
 - Assessed 30, 50, and 70% of 1 rep max

Muscle Power in People with vs. without CVA

- ▶ Muscle power (Stavric & McNair⁸):
 - Decreases with increased load
 - Decreases in bilateral lower extremity in people after CVA
 - Decreased in involved vs. uninvolved lower extremity after CVA
 - Peak power is produced at 30% of 1 rep max

Power Training Post-CVA: Is It Feasible?

- ▶ Morgan et al⁷
 - Feasibility of lower-limb muscle POWER training to enhance locomotor function poststroke
 - POWER: **P**oststroke **O**ptimization of **W**alking using **E**xplosive **R**esistance
- ▶ High velocity concentric contractions
 - “As quickly as possible”
 - Use of task specific and resistive exercises

Power Training Post-CVA: Is It Feasible?

- ▶ Morgan et al⁷: Methods
 - 12 subjects with chronic hemiplegia
 - 6–60 months post stroke
 - No control group
- ▶ 24 training sessions total
 - 3 times per week, 8 weeks
 - Equipment used: Shuttle MVP Pro

Power Training Post-CVA: Is It Feasible?

► Morgan et al⁷: Methods

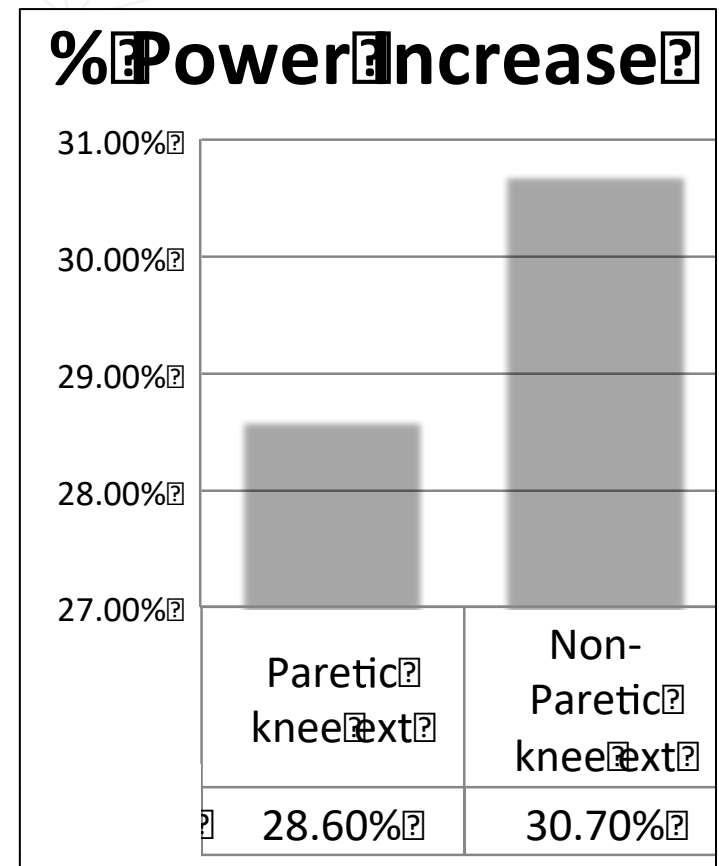
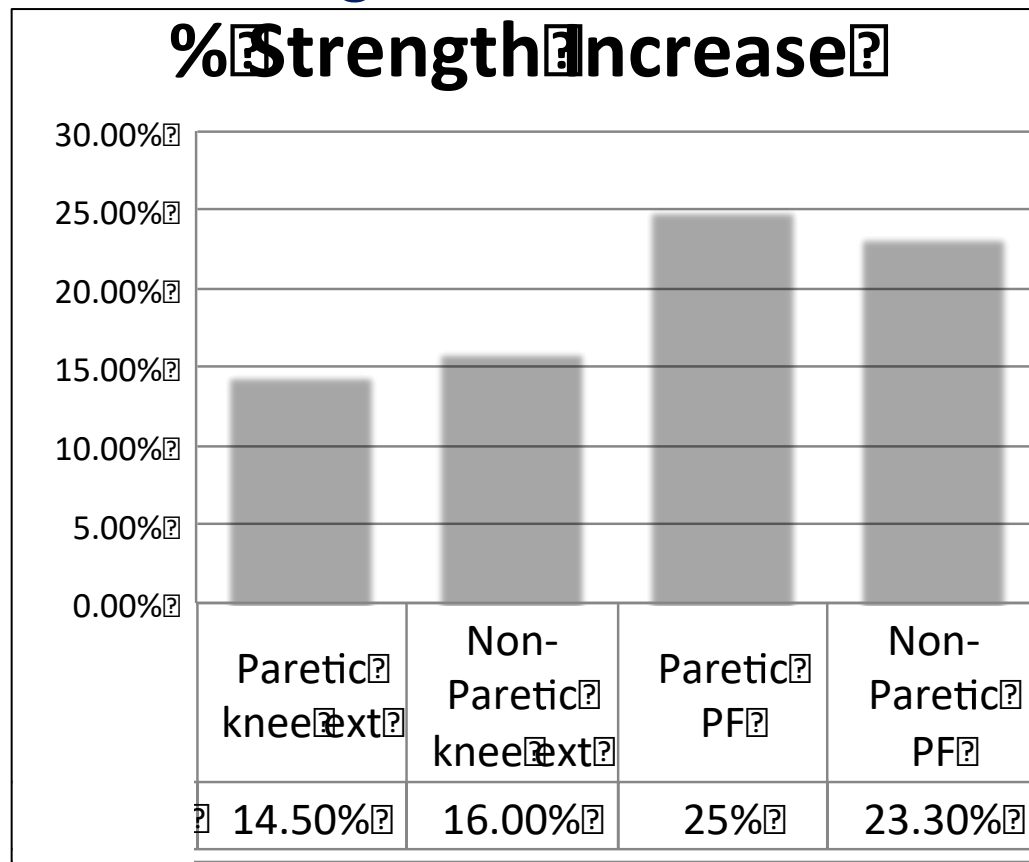
- 2–3 sets of 8–15 reps
 - Unilateral training
 - Resistance and reps progressed as tolerated by each individual
 - Leg press, calf raises, and jump training
- 10 reps of fast walking
 - 10 meters walk at minimum 125% self selected walking speed

Power Training Post-CVA: Is It Feasible?

- ▶ Morgan et al⁷: Outcome Measures
 - Pre-, Post-, 8 week follow-up
 - Walking speed: Self selected and fast
 - Knee extension and plantarflexion strength
 - Knee extensor power
 - Lower limb Fugl-Myer
 - Stroke Impact Scale
 - Dynamic Gait Index
 - 6 Minute walk test

Power Training Post-CVA: Is It Feasible?

► Morgan et al⁷: Results

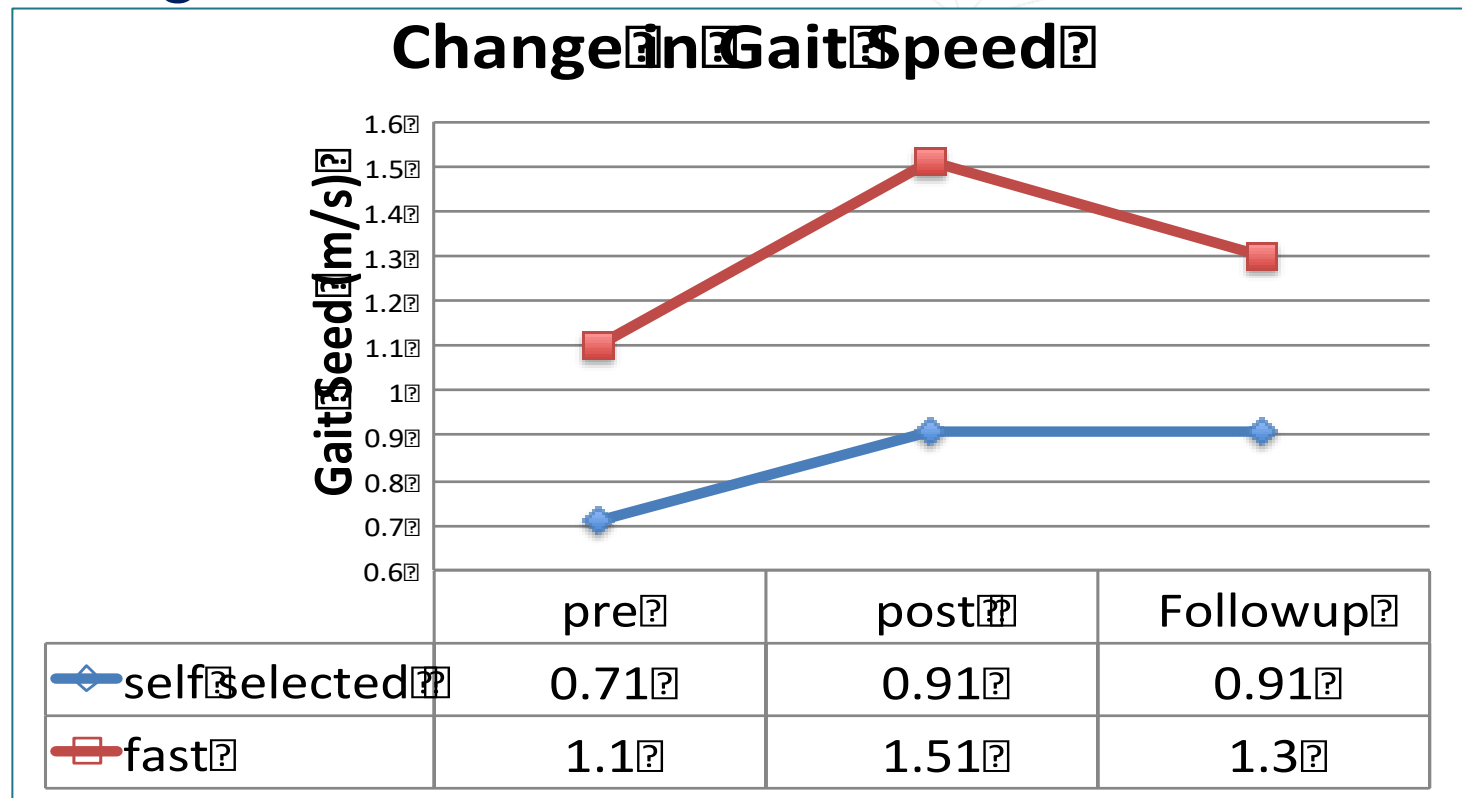


► Increases remained at follow up



Power Training Post-CVA: Is It Feasible?

► Morgan et al⁷: Results



► 28.2% increase in self selected gait speed



Power Training Post-CVA: Is It Feasible?

► Morgan et al⁷: Results

- Clinical measures: no increase following training
 - Stroke Impact scale, Fugl-Myer, 6 Minute walk test, dynamic gait index
 - DGI was significantly increased at follow up

Power Training Post-CVA: Is It Feasible?

- ▶ Morgan et al⁷: Article wrap up
 - Methods are reproducible in clinic
 - 3x per week, 8 weeks
 - Interventions:
 - Increases in muscle strength and power
 - Increase in gait speed
 - More research is being done

Power Training in the Aging Population (McKinnon 2017)


McKinnon et al⁶

- ▶ Typical aging leads to sarcopenia: loss of muscle mass and strength
- ▶ Greater decreases in muscle power vs. strength and muscle mass—Lost at twice the rate
 - Theory: Muscle power may be a more relevant clinical focus and outcome for rehab
- ▶ High velocity muscle power training
- ▶ With goals to improve function in older adults power training may be advantageous over traditional strength training

Power Training in the Aging Population

Uetamsu et al⁹

- ▶ Power training in individuals 70–80 years old
- ▶ 16 sessions over 8 weeks
- ▶ “explosive” muscle training at 30–40% 1 rep max
 - Improved muscle strength (1 rep max and Max voluntary strength)
 - Improved gait speed
 - Improved stride length and plantarflexor work in gait



Slow-Twitch Training: Strength/ Endurance (Type I)

Muscular Strength: Neuro Healthy Population

- ▶ Ability of a muscle/muscle group to produce maximal force (Esco¹)



<https://breakingmuscle.co.uk>²

ACSM Guidelines

	% 1 RM	Reps	Sets	Rest
Novice-Intermediate	60-70	8-12	1-3	1-2 mins
Advanced	80-100	1-8	2-6	2-3 mins

Important Consideration: Force Production

- ▶ Neuromuscular control of muscles
 - Timing
 - Grading of contraction
 - Coordination of agonist and antagonist
 - Repetitive blocked practice of specific motions that will directly impact the individual's function

How To Obtain 1 Rep Max

► Stavric & McNair⁸

- 10 reps submaximal loading
- Load chosen that the participant can lift 2–5 reps
- Load increased 5–15% after each successful trial
- If unsuccessful, load decreased 5–10%
- 2–3 minute rest between each 1 Rep Max attempt
- Goal: Max load, 1 rep, proper technique

How To Obtain 1 Rep Max

- ▶ 1 rep max calculators online and free apps for calculation
 - One rep max calculator by Charles Vanderhoff
 - Enter weight lifted and # of reps tolerated
 - Estimated 1 Rep Max and % of 1 RM ranging from 5–125%

Strength Training for Skeletal Muscle Endurance After CVA

► Ivey et al⁴

- Randomized controlled trial
- Effects of progressive strength training on endurance
- Chronic stroke (>6 months)
- Mild–moderate hemiparesis and could walk with or without AD

Strength Training for Skeletal Muscle Endurance After CVA

► Ivey et al⁴: Methods

- 3x per week for 3 months
- 45 min sessions
- Exercise machines for knee extension, knee flexion, and leg press
- Control Group: 3x per week supervised stretching program.

Strength Training for Skeletal Muscle Endurance After CVA

► Ivey et al⁴: Methods

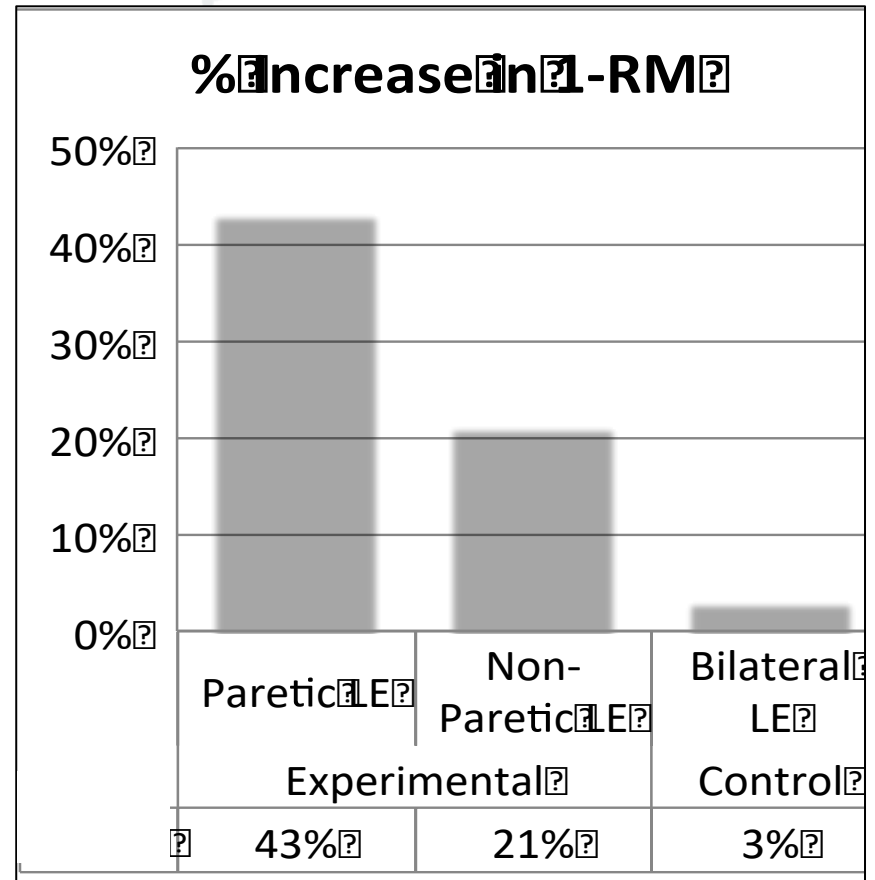
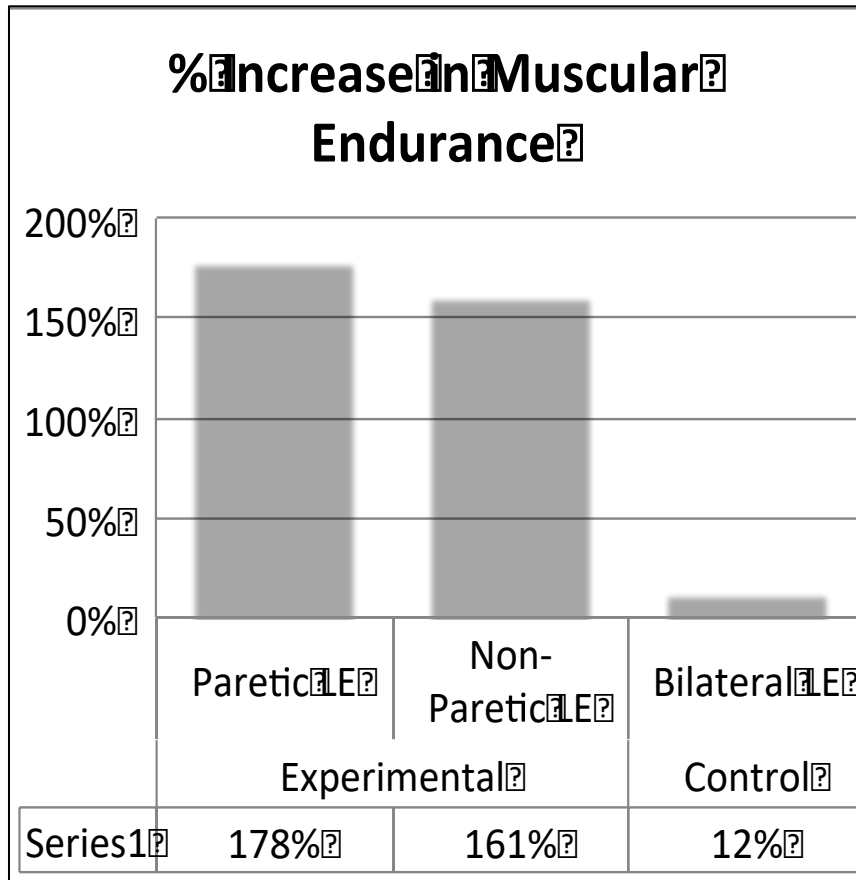
- Unilateral exercise, performed bilaterally
- 2 sets x20 reps
- Resistance goals:
 - Muscle failure at 10–15 reps
 - Lowered to complete 20 reps
 - Goals muscle failure 2–3 per set

Strength Training for Skeletal Muscle Endurance After CVA

- ▶ Ivey et al⁴: Outcome Measures
 - Muscular endurance:
 - # of reps on leg press at 70% original 1 Rep Max
 - Metronome cadence
 - 1 Rep Max
 - 6 Meter walk distance
 - Peak O₂ consumption
 - 10 meter walk speed

Strength Training for Skeletal Muscle Endurance After CVA

► Ivey et al⁴: Results



Strength Training for Skeletal Muscle Endurance After CVA

► Ivey et al⁴: Results

- Strength Group: Improvement in 6 minute walk distance (14% increase)
 - No Increase in control
- No significant difference in VO₂ peak
 - Slight increase in strength group
 - Slight decrease in control group
- No change in 10 meter walk speed

Strength Training for Skeletal Muscle Endurance After CVA

- ▶ Ivey et al⁴: Article Wrap up
 - Methods in the clinic
 - 3x per week for 3 months
 - Duration is long, but we could train HEP
 - Gains in muscle strength and walking endurance
 - No change in gait speed
 - Dosing for strength and endurance

Strength Training for Skeletal Muscle Endurance After CVA

- ▶ Ivey et al⁴: Article Wrap up
- ▶ Large load, muscle failure was often present
 - Consider your patient
 - Frustration, Muscle soreness
 - Fast 1 Rep Max changes may be neurologic changes (Lee⁴)
 - Neurologic factors for first 12 weeks, then hypertrophy



Clinical Application

How to Apply What We've Learned

- ▶ Things to consider when determining approach
 - What are your patient's goals?
 - What are your patient's impairments?
 - How does your patient move?
 - When are falls happening?
 - What do they need assistance with?
 - Are multiple approaches needed?

Functional Improvements

- ▶ Type I Muscle fiber training
 - Improvements in Gait endurance (6MWT)
 - No significant change in self selected gait speed
- ▶ Type II Muscle fiber training
 - Improvements in self selected gait speed (10MWT)
 - No significant change in endurance

How Do We Bias Different Fiber Types with Training Strategies

▶ Type I Fiber

- Controlled movements, more weight
- Open/closed chain movements
- Resisted functional movements
- Increased # of reps to target muscle fatigue/endurance

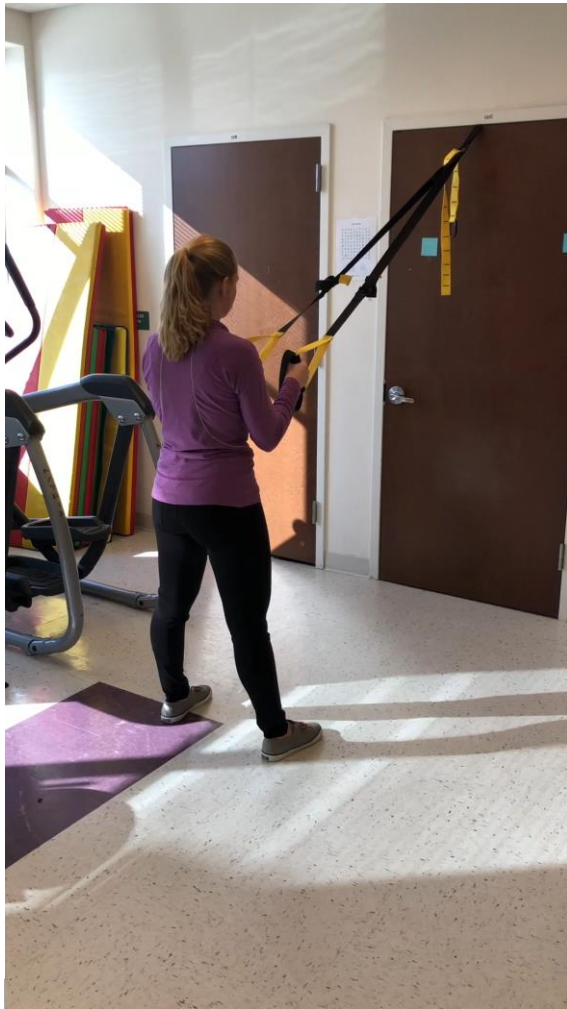
▶ Type II Fiber

- Fast motions, lower weight/resistance
- Open/closed chain movements
- Functional movements performed quickly
 - Fast walking, running, jumping, as many of a movement in a time period

Clinical Implementation: Fast-Twitch

- ▶ Can give support initially, progress out of support when they can!
 - Ideas for support: Fall prevention harness, TRX, railings/bars, trampoline
- ▶ Isolated movements, but faster!
 - Sit<>stand, calf raises, step ups
- ▶ Jumping
 - Squat jumps, lateral bounds, skipping, single leg, plyometrics
- ▶ Fast Walking/interval training
- ▶ Running intervals
- ▶ Agility ladders

Clinical Implementation: Fast-Twitch: TRX Example



- ▶ Can utilize TRX system to provide support as needed

Clinical Implementation: Fast-Twitch Fiber Training: Blaze Pods



- ▶ Can utilize equipment to increase drive and speed/intensity of movements

Clinical Implementation: Fast-Twitch Fiber Training: Blaze Pods

► Be Creative!



Clinical Implementation: Slow-Twitch

- ▶ Add resistance and perform to fatigue
 - 8–12 reps for strength
 - 15–20 reps for endurance
 - Think of resistance using body weight, tubing/bands, weighted vests, free weights, ankle weights
 - Incorporate with any classic open/closed chain strengthening
 - Incorporate with functional strengthening: sit<>stand, step ups
- ▶ Endurance training



Case Examples

Patient A

- ▶ 68 yo female s/p CVA. She does well moving around her home independently and has had one fall. She used to like to go to the mall with her grandchildren, but has not been able to do this since her stroke because she gets too tired. She tried this once since her stroke, but was so fatigued after that she fell that evening walking to her bedroom. She doesn't like to use her w/c in the community.

**Fast-
Twitch
Focus**

**Slow-
Twitch
Focus**

**Needs
Both**

Patient B

- ▶ 79 yo male s/p L CVA with multiple medical comorbidities. He has developed a very slow gait pattern and has had many falls at home, especially when he is trying to get to the bathroom on time. He would like to improve his walking.

**Fast-
Twitch
Focus**

**Slow-
Twitch
Focus**

**Needs
Both**

Patient C

- ▶ 45 yo male s/p R CVA, very active PLOF, runs a 5K per month. He is impulsive with cognitive impairments present including difficulty with attention. Has difficulty with getting up from different surfaces, stair climbing, and balance. He is unable to achieve push off with gait. He fatigues quickly. He has not fallen, but makes his wife nervous.

**Fast-
Twitch
Focus**

**Slow-
Twitch
Focus**

**Needs
Both**



Questions?



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Thank you!

