Turning Negatives Into Positives: A New Approach to Eccentric Training
Disclosure & Conflict of Interest

• The presenter has no conflicts of interest or financial relationships to disclose.
Eccentric Exercise

- Historical perspective
- Eccentric muscle mechanics
- Fallacies vs. Facts
  - Injury/Damage vs. Rehab/Benefits
- Safety, Feasibility & Application
  - Contribution to Injury, Prevention, Rehabilitation & Sport Performance
Push Me, Pull You

Resisting the reverse moving pedals with the leg muscles inducing lengthening, "negative work"

Pushing the pedals forward with the leg muscles inducing shortening, "positive work"
Resisting the reverse moving pedals with the leg muscles inducing lengthening, "negative work"

Pushing the pedals forward with the leg muscles inducing shortening, "positive work"
What is the COST of WORK?

- Energy cost of doing work
  - Fenn Effect (1924)
  - Energy required for force production is increased when muscles shorten

- Negative Fenn Effect
  - Energy liberated is reduced when muscle is stretched while contracting
Why would Con exercise elicit a greater RPE than Ecc exercise?

• Metabolic Cost

Meyer et al. (2003) MSSE
Lower Metabolic Demand for Ecc Ex

Responses to Con vs. Ecc Exercise

- Rating of Perceived Exertion

EXS 216 Kinesiology (2015)
Elmer et al. (2012) Scan J Med Sc Sports
Actin-Myosin Bonds???

- Chemical reactions that consume ATP are not simply reversed during lengthening contractions
- Speculation that actin-myosin bonds are disrupted mechanically
- Thomas McMahon (1995)
Two Defining Properties!!!

- Force production is uniquely high
- Energy cost to produce force is uniquely low
Fallacies vs. Facts of Eccentric Muscle Contraction

- Injury/Damage vs. Rehab/Benefits
  - 1000 vs. 50 citations
- Delay Onset of Muscle Soreness
- No Pain, No Gain???
Eccentric Training - CAUTION!!!

- **Rhabdomyolysis**
  - Condition in which damaged skeletal muscle (myoglobin) breaks down.
  - Myoglobin released into the bloodstream
  - Kidney failure

- **Symptoms**
  - Muscle pain
  - Vomiting
  - Confusion
No Pain, No Gain?

Flann et al. (2011) J Exp Bio

Table 2. Quadriceps muscle volume and isometric strength

<table>
<thead>
<tr>
<th></th>
<th>Pre-trained group (PT)</th>
<th>Naive group (NA)</th>
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<tbody>
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<td></td>
<td>Pre-training</td>
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<td>Quadriceps volume (cm³)</td>
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<td>104.5±64.5</td>
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Mean values (N=14, ±s.e.m.) of the PT and NA groups before and after the 12-week resistance training. *Significant difference (P<0.05) was seen within the groups for pre- and post-cross volume values as well as pre- and post-strength results. No statistical difference (P>0.05), however, was present between the NA and PT groups for either muscle volume or strength.
Safety & Feasibility in Rehab

Eccentric Rehab Applications

- Cardio-pulmonary Disease
- Frailty
- Knee Surgery Injury
- Neurologic Disease
- Tendinopathy

Physical Dysfunction

Atrophy

Weakness

LaStayo et al. (2014) JAP
Improvements in Muscular & Multi-Joint Function

- Muscle Size
- Muscular Function
- Mobility
Application of Eccentric Training

- Progression
- Mode
Acute Responses to Ecc Exercise

Graph 1: Pain (cm) vs Time (hours)
- Right Leg (Concentric)
- Left Leg (Eccentric)

Graph 2: RPE (Rating of Perceived Exertion)
- CON Leg
- ECC Leg
Responses to Chronic Eccentric Training

- Muscle Soreness

LaStayo et al. (2000) *Am J Physiol Regul Integr Comp Physiol*

Leong et al. (2013) *IJS M*
Table 2. Progression of eccentric cycling training intensity and duration. Note that all training was performed at 60 rpm.

<table>
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<tr>
<th>Weeks of Training</th>
<th>% Baseline $P_{\text{max}}$</th>
<th>Duration (min)</th>
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<tr>
<td>1</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>7</td>
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<tr>
<td>4</td>
<td>35</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>45</td>
<td>9.5</td>
</tr>
<tr>
<td>7</td>
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$P_{\text{max}}$: Maximum concentric cycling power.
LaStayo et al. (2000) *Am J Physiol Regul Integr Comp Physiol*
Eccentric Training Intensity

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No Pain, No Gain?

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Eccentric Training

Frail elderly adult patients, mean age of 80.2 years

“...maintained 216 W for 15 minutes, and the least frail maintained a workload in excess of 400 W for 20 minutes...”

LaStayo et al. (2003) *J Gerntol*
12 week Progression

LaStayo et al. (2014) JAP
Algorithm for temporary pain, adverse reactions & missed sessions

Eccentric-Negative Work Progression

Program Initiated: 3x/wk

1-2 consecutive sessions missed or Minimal leg/joint pain (0-4 on VAS)
- Continue progressive work program

3 consecutive sessions missed or Moderate leg/joint pain (5-7 on VAS)
- Maintain total volume from last completed session

4 or more consecutive sessions missed or Minimal leg/joint pain (8-10 on VAS)
- Stop Exercise and re-evaluate source of pain. If clinically appropriate to reinitiate exercise revert back to total volume at the beginning of the last week that was completed
How do we perform Ecc Training?

• Modes of Ecc Ex
  ▫ Be Justin Bieber?
  ▫ Agaton
  ▫ Isokinetic Dynamometer
  ▫ Eccentric Cycle Ergometer
Eccentric Cycle Ergometer
Eccentric cycling is a potent stimulus for improving muscular function in:

- Young healthy individuals
- Athletes
- Patients with tendinopathies
- Frail and elderly
- ACL patients
- Parkinson’s disease patients
- Cancer survivors
- Total knee replacement patients
- Astronauts & Patients with low bone mass
Eccentric Exercise for Preservation of Muscle and Bone

Chee Hoi Leong, Ernie Rimer, and James C. Martin.
Neuromuscular Function Laboratory
Department of Exercise & Sport Science
College of Health
Exposure to Microgravity
Reduced Muscle Mass and Function &
Reduced Bone Mineral Density
Summary

- Intervention geared toward individuals with:
  - Low muscle mass reserves and quality
  - High mobility impairments
  - Dwindling self-independence

- Few countermeasures are superior to traditional resistance exercise
  - Hypertrophy and attenuate muscular decline

- Safety, Feasibility & Clinical Benefits of Eccentric Exercise becoming more apparent

- Further development of parameters to optimize:
  1. Intensity
  2. Duration
  3. Modes
Thank You!!!
References


