Addition Through Restriction!

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Disclosure
I have no financial relationships to disclose

WARNING!
Blood Flow Restriction Training is an advanced technique that requires precise pressures, durations, and frequency as well as careful cuff placement and consistent supervision of individual patients and their responses during training. Therefore, Blood Flow Restriction Training should only be utilized by well-trained experts.
Primary Questions

Can Blood Flow Restriction (BFR) Training improve the components of physical fitness and the recovery process?
What populations could benefit from using it?

Presentation Objectives

Summarize current physiological and clinical findings regarding BFR training.
Identify potential risks and populations that would benefit from BFR training.
Evaluate if BFR training would be effective in improving outcomes relevant to population of interest.

Background

What is BFR?
- Originally established in 1970’s by Dr. Yoshiaki Sato in Japan
- Known as Kaatsu Training
- Added pressure is achieved using:
  - A cuff
  - Placed proximally around limb
  - Partially restricts arterial blood flow in
  - Full restricts venous blood flow out
- Reduced blood flow induces an ischemic/hypoxic environment
- Enhances the training effect in exercising muscle
- Leads to increased muscle mass and strength
**Physiology**

The primary mechanisms that stimulate growth include:

- Acute cell swelling, which promotes hypertrophy
- Metabolic accumulation: stimulates anabolic growth factors
- GH, NE, and La concentrations increase transiently post-exercise
- Transient increases in inflammatory cytokines such as, IL-6
- Stimulates signaling to the mTOR pathway
- Proliferation on myogenic stem cells may occur
- Elevated activation levels at low force generation
  - May result in higher glycolytic fibers activation

Loenneke, 2018; Scott, 2016; Pearson, 2015; Nielsen, 2012; Fujita, 2007; Yasuda, 2012; Gentil, 2006; Takarada, 2000

**Contraindications**

- Poor circulatory systems
- Obesity
- Diabetes
- Arterial calcification
- Sickle cell trait
- Severe hypertension
- Venous thromboembolism
- Peripheral vascular compromise
- Sickle cell anemia
- Extremity infection
- Lymphadenectomy
- Cancer/tumor
- Extremity with dialysis access
- Acetabular
- Open fracture
- Increased intracranial pressure vascular grafts
- Medications known to increase clotting risk

Dephillipo, 2018, Owens Recovery Science

**Benefits - Healthy Young Population**

- Low-intensity resistance exercise with BFR has shown that hypertrophic adaptations
- Useful when individuals don’t have access to heavier loads
- Used as Supplemental training
- Lighter intensity - active recovery day
- Maintain physiological stress
- Reduce the mechanical stress

Wilk, 2018; Centner, 2019; Wilson, 2013; Spranger, 2018; Patterson, 2019
Benefits - Elderly

- Combat sarcopenia in elderly populations
- Allows for low intensities which reduces bone stress
- Possible benefit in upper and lower limb injury rehabilitation
  - Such as hip/knee replacements
- Provides a safer alternative to conventional resistance training
  - Must be cautious of the many contraindications

Centner, 2019; Ladlow, 2018; Wilk, 2018; Bittar, 2018

Benefits - Rehabilitation

- Possible benefits limb injury rehabilitation
- Combat atrophy through passive BFR during immobilization periods
- Low load RT + BFR produces greater size and strength gains than without BFR
- BFR training during rehabilitation show promise
- Further research needed to make definitive conclusions on both effectiveness and safety

Wilkinson, 2019; Hughes, 2017

Muscle Growth with BFR

- Sedentary BFR
  - Swelling
- BFR + Walking
  - Swelling
  - Mechanical
- BFR + Resistance Training
  - Swelling
  - Mechanical
  - Hypoxia
  - Muscle Growth
Passive BFR

- Passive BFR has not been researched as extensively
- Shows promise to combat atrophy
- Mostly for:
  - Bed-rest patients
  - Individuals with immobilized limb

Aerobic Exercise + BFR

- Normally applied during walking or cycling
- Generally used with low intensities (<50% HRR)
- BFR may provide improvements in VO2max
- More difficult to maintain cuff pressures
- Literature lacks standardized cuff pressures

Prescription Recommendations

- May lead to aerobic endurance improvements in athletes as well as health young adults and elderly
- Adaptations in:
  - Activities of daily living
  - Health
  - Well-being

### TABLE 1: Model of exercise prescription with P-BFR

<table>
<thead>
<tr>
<th>Guidelines</th>
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</thead>
<tbody>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Restriction time</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Sets</td>
</tr>
<tr>
<td>Cuff</td>
</tr>
<tr>
<td>Rest between sets</td>
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<tr>
<td>Restriction form</td>
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</tbody>
</table>

### TABLE 2: Model of exercise prescription with BFR-AE

<table>
<thead>
<tr>
<th>Guidelines</th>
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<tbody>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Intensity</td>
</tr>
<tr>
<td>Restriction time</td>
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<tr>
<td>Type</td>
</tr>
<tr>
<td>Systolic pressure</td>
</tr>
<tr>
<td>Cuff</td>
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<tr>
<td>Exercise mode</td>
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</tbody>
</table>
Resistance Training + BRF

Hypertrophy
- Has consistently shown hypertrophic adaptations
- Induced with much lower exercise intensities (<50 % 1-RM)
- Increases observed in healthy young adults in as little as 1-3 weeks
- Hypertrophic adaptations may occur before neural adaptations
- Traditional resistance training still produces larger increases in hypertrophy

Resistance Training + BFR

Strength & Power
- Can speed up the recruitment of fast-twitch muscle fibers
- Short duration, low intensity BFR training for ~4-6 weeks has been shown to 10-20% increases in muscle strength
- Training durations >6 weeks seem to offer greater returns in strength adaptation
- The lower mechanical demands may allow for higher training frequency
- Traditional heavy mechanical load resistance training still produces larger increases in strength

Prescription Recommendations
- The final restriction
- Pressure and cuff width recommendations vary widely
- Pressures range from 50-300 mmHg
- Cuff width 3-20 cm
Possible Negative Consequences

- Complication occurs less than 1% of the time
- Possible misuse or improper placement of cuffs
- Greater than 50% occlusion increase in risk of complications
- Fainting, dizziness, numbness, pain, discomfort, and delayed onset muscle soreness
- Even healthy individuals are potentially at increased risk for harmful cardiovascular events
- Possibility of serious tissue damage due to fine microdamage in blood vessels

Loenneke, 2014; Brandner, 2018; Spranger 2015

Possible Negative Consequences (Cont.)

- Numbness
- Deep vein thrombosis
- Pulmonary embolism
- Nerve injury
- Skin injury
- Tourniquet pain
- Respiratory, Cardiovascular, Cerebral circulatory and hematological issues

Brandner, 2018; Patterson, 2019

Take Home Points

- In rehabilitation may serve as a bridge to accelerate the recovery process
- In healthy elderly may serve as a lower intensity alternative to combat sarcopenia or when heavy load training is contraindicated
- In healthy adults and athletes will not replace traditional resistance training
- May work in supplement to increase training frequency without increasing mechanical stress
- Wide range of contraindications to consider before prescribing
- More research is needed in the area of
  - Understanding the physiological process
  - Use in the rehabilitation process
  - Utilization for aerobic adaptations
References