Blood Flow Restriction Rehabilitation
Kyle Schumacher, PT, DPT, ATC

Objectives
- Define and explain blood flow restriction (BFR) rehabilitation and its history
- Demonstrate an understanding of the mechanisms of BFR
- Become familiar with the equipment associated with BFR
- Understand BFR protocols and exercise prescription
- Know the precautions, contraindications, and risks associated with BFR

History of BFR
- Began with the Department of Defense
- Problem → limb salvage patients spending months/years in rehab only to have partial/full amputations
  - Pain and low level of function
- Exoskeleton developed to act like a prosthetic
  - Problem → needed to be strong in order to wear
- Blood flow restriction provided the solution
- Patients able to exercise with light weight and show strength gain
What is Blood Flow Restriction?

- Tourniquet applied to a proximal extremity
- Equipment
  - Instrumentation
  - Cuff & hoses
  - Only FDA approved BFR device
- Exercises completed during occlusion
- Reducing blood flow to exercising limb with light weights → increase in strength and hypertrophy

MECHANISMS BEHIND BFR?

- Fast Twitch Fiber Recruitment
  - Resulting in anaerobic metabolism
  - Cellular (myocyte) swelling
- Systemic Response
  - Increased lactate, hydrogen, growth hormone, and IGF-1
- Muscle Protein Synthesis and Gene Expression

Fast Twitch Fiber Recruitment

BFR:
- Limit oxygen supply to muscle
- Increase in lactate drives an increase in muscle activation
- Inhibition of surrounding muscle fibers
- Increased motor units = maintained muscle force production
- More hypoxic state = more fast twitch fiber activation
Cellular (Myocyte) Swelling

- Pump effect
- Theory of cellular hydration and muscle protein synthesis
- BFR without exercise can help reduce atrophy

Systemic Response

- Cori Cycle / Anaerobic metabolism
  - Stimulates Growth Hormone production
  - Stimulates release of IGF-1
  - Increased GH & IGF-1
- Gains in protein synthesis and muscle mass

Muscle Protein Synthesis
Gene Expression

Muscle Growth & Hypertrophy
- Net Protein Balance = Muscle Protein Synthesis - Muscle Protein Breakdown
- Mammalian Target Rapamycin Complex 1 (MTORC-1) = signaling pathway responsible for muscle protein synthesis
  - Associated with down-regulation of Myostatin

Safety

- Possible Contraindications
  - Venous thromboembolism
  - Peripheral vascular compromise
  - Previous revascularization of the extremity
  - Extremities with dialysis access
  - Stable collateral
  - Extremity infection
  - Open fracture/soft tissue injury
  - Increased intracranial pressure
  - Severe crush injury
  - Severe hypertension
  - Cancer
  - Tumor distal to the tourniquet

- BFR Studies Addressing Safety
  - Clark (2011)
  - Cortez-Cooper (2005)
  - Dohring (2006)
  - Furl (2011)
  - Fry (2010)
  - Hamilton (2001)
  - Hylden (2014)
  - Iida (2007)
  - Kawano (2008)
  - Kim (2009)
  - Loenneke (2011)
  - Madarame (2010)
  - Noordin (2009)
  - Takano (2005)

Exercise Prescription

- Frequency
  - Strength: 2-3 days/week
  - Endurance: 4-6 days/week

- Duration
  - 10 weeks
  - Hypertrophy seen after 2 weeks

- Rest Periods
  - 30" rest between sets
  - 1' between exercises

- Training Intensity with BFR
  - Aim for 15-30% 1 RM
  - 2-3/10 on the OMNI-RES
Exercise Prescription
- Tourniquet Cuff Pressure
  - 80% occlusion for LE
  - 50% occlusion for UE
- Target Exercise Volume
  - 4 sets of 30/15/15/15
  - 30 sec rest between sets
  - 2-sec concentric & 2-sec eccentric
- Exercise Selection
  - Any upper or lower extremity exercise used in the rehab setting
  - Endurance: walking or cycling
  - Concurrently with e-stim & biofeedback

Ongoing Clinical Research
- Knee Arthroscopy Trial (completed/submitted for publication)
- ACL Reconstruction
- Chronic Thigh Weakness After Surgery
- REPAIR Study (Femur Fracture)
- Chronic Achilles Tendinopathy
- Distal Radius Fractures
- Meniscus Tear/Repair Study
- Regenerative Medicine and BFR
* These trials span across 14 different centers and total more than $6 million in grant funding.

Demonstration & Questions
Contact Information

Kyle Schumacher, PT, DPT, ATC
Senior Associate Athletic Trainer / Co-Rehabilitation Coordinator
Northwestern University Athletics
kyle.schumacher@northwestern.edu
Office: 847-491-8866