

# Blood Flow Restriction

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## Objectives

- Define Blood Flow Restriction
- Explain the science behind the use and benefits
- Understand how to use BFR – protocols and prescriptions
- Identify the risks, precautions, and indications for BFR



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## Blood Flow Restriction

- Complete exercise at low loads
- Get similar results
  - Strength
  - Hypertrophy
- Effective when high load training is not possible
- Faster return to ADLs and sports



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## History



- Department of Defense
- Limb salvage patients → amputation
- Exoskeleton
- Needed to be strong
- Blood flow restriction provided the solution



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## Blood Flow Restriction

- Tourniquet applied to a proximal extremity
- Partial arterial occlusion
- Exercises completed during occlusion
- Increase in strength and hypertrophy



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## Strength and Hypertrophy

- Evidence shows the increase in strength and hypertrophy
- Why?
  - Increased fiber type recruitment
  - Metabolic accumulation
  - Activation of muscle protein synthesis
  - Cell swelling
  - All? Some?



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## Fast Twitch Recruitment

- Limit oxygen supply to working muscle
- Forces anaerobic metabolism
- Byproduct of lactate
  - Increase muscle activation
  - Larger motor units
- More hypoxic state, more fast twitch activation




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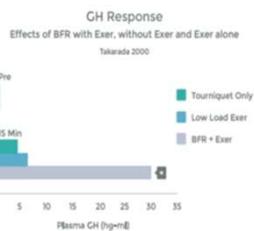
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## Metabolic Accumulation



- ↑ Growth Hormone
  - Collagen synthesis
- ↑ IGF-1 and satellite cells
- Down regulation of myostatin




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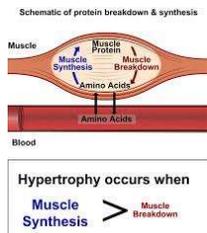
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## Activation of Protein Synthesis

Muscle Protein Synthesis  
- Muscle Protein Breakdown  
**Net Protein Balance**

Signaling pathway is  
mTORC1

- Increased with BFR




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## Cell Swelling



- Fluid plasma shift
  - Not venous congestion
- BFR only
  - Reduced atrophy



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## Proximal Gains

- No occlusion of trunk musculature
- Potential gains
  - Downstream fatigue?
  - Systemic response?



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## Risks

- Poor circulatory system
- Obesity or loose limb tissue
- Arterial calcification
- Abnormal clotting times
- Diabetes
- Sickle cell trait
- Tumor
- General infection
- Hypertension
- Cardiopulmonary conditions
- Renal compromise
- Clinically significant acid-base intolerance
- Atherosclerotic vessels
- Patients taking anti-hypertensives and/or creatine supplements



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## Contraindications

- Venous thromboembolism
- Impaired circulation or peripheral vascular compromise
- Sickle cell anemia
- Extremity infection
- Medications known to increase clotting risk
- Open fracture
- Open soft tissue injuries
- Post-traumatic lengthy hand reconstructions
- Severe crushing injuries
- Severe hypertension
- Elbow surgery (where there is concomitant excess swelling)
- Vascular grafting
- Cancer



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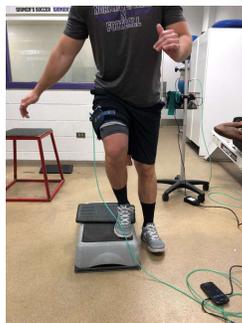
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## Exercise Prescription

- Frequency
  - Largest effect size 2-3 x week
  - Alternate endurance and strength
- Duration
  - 10 weeks
  - Hypertrophy seen after 2 weeks
- Rest Periods
  - Within exercise
    - 30 seconds between sets
    - Cuff stays inflated
  - Between exercises
    - 1 minute between exercises
    - Cuff is deflated



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## Exercise Prescription



- Tourniquet Cuff Pressure
  - Dependent on limb size, soft tissue, cuff width, device
  - Most studies do not report
- Limb Occlusion Pressure (LOP)
  - Minimal amount of pressure to occlude arterial flow
  - 3<sup>rd</sup> generation tourniquet system allows for personalized pressure readings w/o Doppler
  - 80% lower extremity
  - 50% upper extremity



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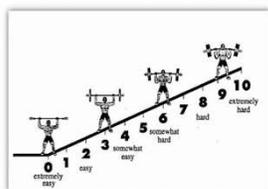
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## Exercise Prescription

- Intensity
  - 15-30% 1RM
  - RPE has high correlation to MVC
  - Weights/resistance 2-3/10 on RPE
- Exercise selection
  - Any exercise typically used in rehabilitation
  - 30/15/15/15
  - 2 sec concentric, 2 sec eccentric




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## Research

PubMed – “Blood Flow Restriction” – 2018  
90 Published articles

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|--|--------------------------------------|
| • Cycling                              | • Incomplete spinal cord injury      |
| • Functional improvements in Parkinson | • Bone metabolism                    |
| • Blood pressure response              | • Achilles tendon rupture            |
| • Knee surgery                         | • Prehab for total knee arthroplasty |
| • Pain and RPE                         | • Knee osteoarthritis                |
| • Chronic ankle instability            | • Adolescent lower body strength     |
| • ACL rehab                            | • Walking in older adults            |
| • Elderly strengthening                | • Sprint training                    |
| • Anterior knee pain                   |                                      |

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## Research

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## PEARLS from the Clinic

- Start with low level exercises
- Cuff width matters
  - Automated LOC
- Not a “favorite” rehab
  - Tourniquet pressure
  - Realization of gains
- Post-op rehabilitations
  - Disuse atrophy




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## Thank You!




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