

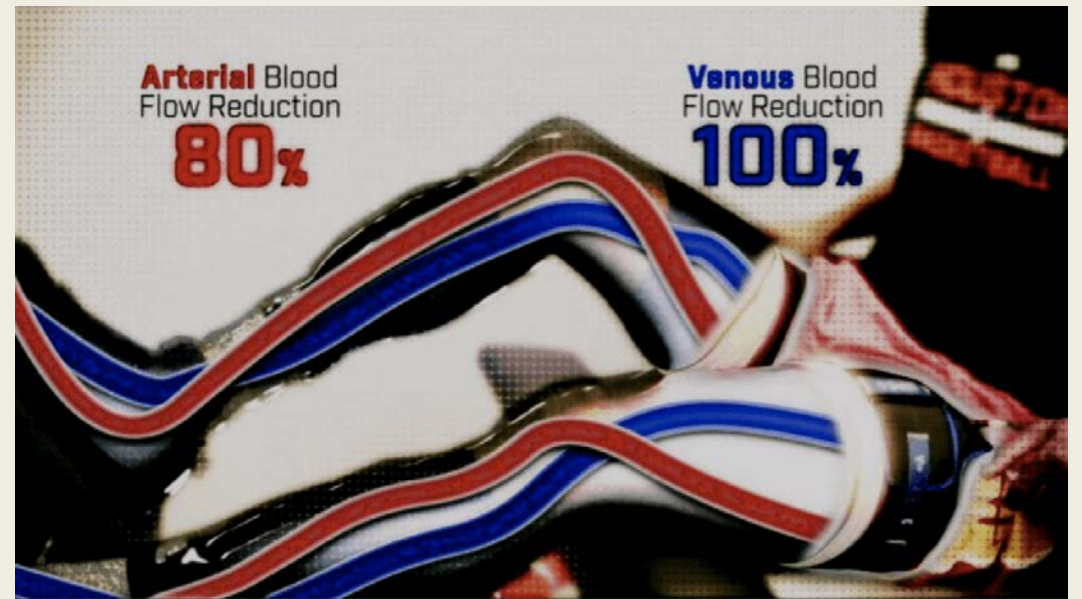


BLOOD FLOW RESTRICTION: WHY YOU SHOULD BE USING IT

Kenneth Mynatt, PT, DPT, ATC, LAT
Emory Sports Medicine Complex
kenneth.mynatt@emoryhealthcare.org

WHAT IS BFR?

- Medical device
- Partial occlusion of arterial inflow
 - *Restricts oxygen delivery to muscle*
- Full occlusion of venous outflow
- KAATSU
 - *Japan 1966*
- Limb Salvage



GOALS OF BFR

- Limit negative effects of immobilization/disuse
- Limit negative effects of NWB status
- Limit post-operative atrophy
- Promote environment for recovery
 - Angiogenesis
 - Metabolic stimulus
 - Muscle hypertrophy



DWIGHT HOWARD BFR

- <https://www.youtube.com/watch?v=nbGNFSB-xcQ>
- Start at 2:00

PATIENT POPULATIONS

- Post-operative
- Elderly
- Osteoarthritis
- Amputee



QUESTIONS/CONCERNS WITH BFR IN A CLINICAL SETTING?

- Is it safe to restrict blood flow after surgery?
- Will my patient tolerate this?
- What are risks/contraindications?
- How do you determine 1RM post-op?
- How do you manage BFR in a busy clinic?
- What does it do?

CURRENT ISSUES IN REHAB

- Immobilization & NWB¹⁴
 - 5 days: Loss of Quad CSA >3%, Strength >9%
 - 14 days: Loss of Quad CSA >8%, Strength 22%
- Arthrogenic inhibition
 - 20 cc^{12,13}
- ACLR quad deficit 1 year post-op:¹⁹
 - 60 deg/sec: male 15.8%; female 22.9%
 - 180 deg/sec: male 13.5%; female 19.7%
- Muscle morphology/cellular changes post ACL tear²⁷



Atrophy³⁶

THIS IS WHERE THINGS GET SCIENCEY





METHODS OF ACTION

- **Metabolite theory**³¹
 - *Increase in local growth factors*
 - IGF-1 = (GH, MPS, satellite cells)
 - Inhibition of Myostatin
- Increase in myogenic stem cell proliferation³⁴
- Blood lactate³²
 - *Similar blood lactate level BFR vs HL*
 - Increased iEMG and motor unit recruitment
 - *Growth Hormone*
 - GH = (IGF-1, satellite cells)

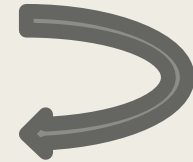
METHODS OF ACTION CONT.

- **Cell Swelling**²⁸

- *Cell hydration (changing intra and extracellular pressure gradient)*

- **Mammalian target of rapamycin (mTOR)**²⁸

- *Regulates muscle protein synthesis*



Dehydration down-regulates mTOR

- **Vascular Endothelial Growth Factor (VEGF)**³³

- *Angiogenesis, increased muscle hemoglobin*



HEAVY RESISTANCE TRAINING

- ACSM³⁵
- Hypertrophy: 60-70% 1RM, 8-12 reps, 3 sets, 3 days/week
- "Optimal hypertrophy... combination of mechanical and metabolic stimuli"
- Overload/Size principle
 - *increase blood lactate*
 - *Increases GH & IGF, inhibition of myostatin*

PARAMETERS

- Wide Cuff (13.5 cm)⁹
- Limb Occlusion Pressure¹⁰
 - 80% LE
 - 50% UE
- Intensity: 20-40% 1RM^{11,17}
- Reps/sets: 4 sets, 30/15/15/15¹⁷
- Duration: 5-10 minutes, reperfuse between exercise
- Frequency: 2-3x/week
- Cuff Placement: proximal thigh/arm





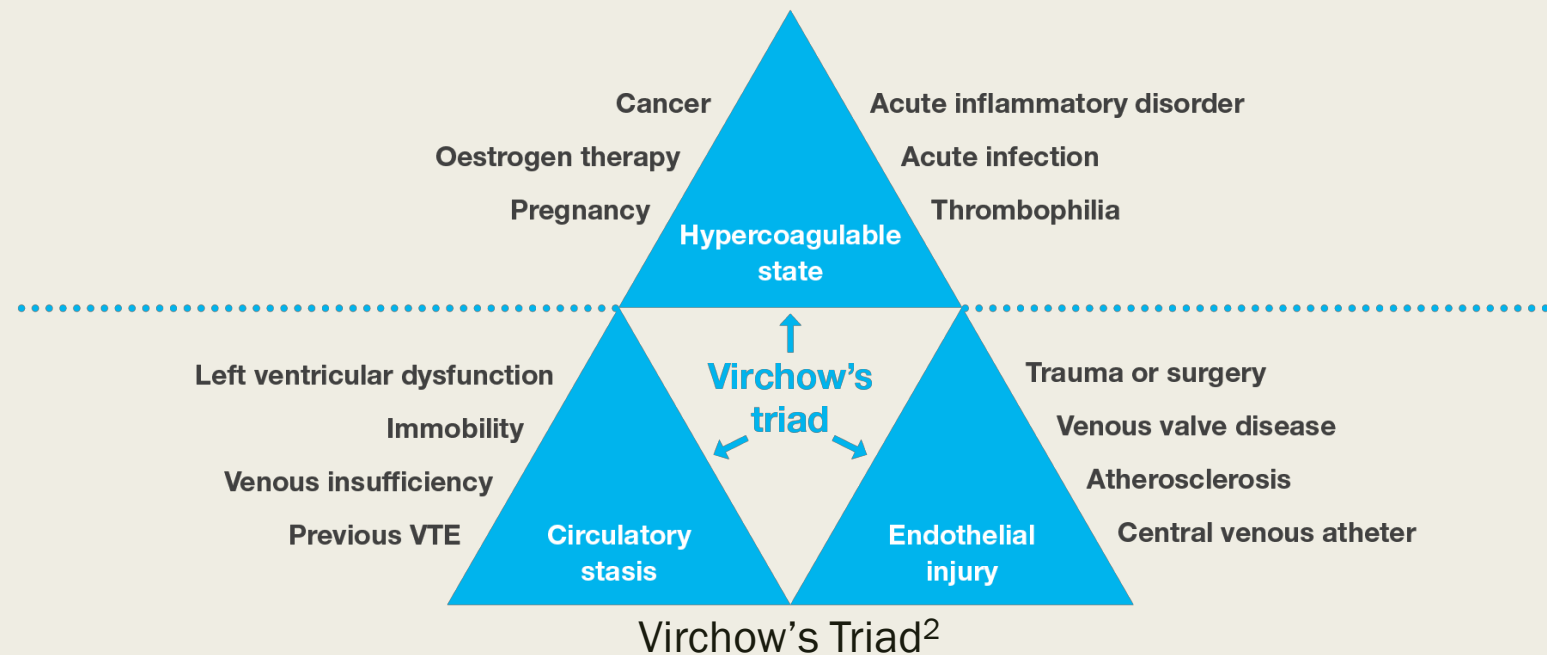
BENEFITS OF BFR

- Environment for muscle hypertrophy
- Motor unit recruitment³²
- Decreased joint loading
- Decreased muscle damage
- Use in combination with NMES¹⁸
- Pain reduction³⁷
- Possible proximal gains: distal fatigue creates proximal recruitment?

RISKS

■ Thrombus³⁸

- *“The collective literature suggests that a proper prescription of BFR in the context of Virchow’s triad would not heighten the risk of developing VTE”*



RISKS cont.

- Screening:³⁸
 - *Recent immobility*
 - *Pre-existing hypercoagulability*
 - Thrombophilia, pregnancy, sickle cell, infection, DVT, meds, CA
 - *Open and unhealed soft tissue injury*
 - *Operative site not under cuff*
- Homan's sign, color of limb, girth, wound drainage
- Numbness (<2%)³⁹
- Pain: Increased muscle pain³⁷

IDEAL PATIENT POPULATION

- Adolescence/young adult
- Healthy
- Post-surgical
 - *NWB/Immobilized*
- Examples:
 - *ACLR, meniscal repair*
 - *Tib/fib fx, achilles repair, Lisfranc*
 - *Osteochondral fractures/defects*





ACLR EVIDENCE

- 2000 Medicine & Science in Sports & Exercise²⁵
 - *14 days post-op: Loss of CSA BFR (9.4%); control group (20.7%)*
- 2019 UK National Health Service²¹
 - *BFR: Y-balance, ROM, joint pain, effusion*
 - *Similar effects in knee extension/flexion torque, muscle thickness VL, pennation angle*
- 2019 Journal of Sport Rehabilitation⁴⁰
 - *15 week intervention: increase in greater knee ext. torque and CSA*
 - *13 day intervention: no difference in CSA*
 - *10 day intervention: less knee ext. CSA loss than control*



ACLR EVIDENCE cont.

- 2016 Journal of Sport and Health Science²⁴
 - *16 days post-op: No change in quadriceps CSA loss between groups*
- 2019 American Physical Therapy Association – TBD
 - *Univ. Of Kentucky RCT*
- 2020 American Journal Of Sports Medicine⁴¹
 - *No difference in max isokinetic or isometric knee extension*
 - *No difference in rectus femoris muscle volume*
 - *No change at end of intervention nor at return to activity*



EVIDENCE CONT.

- Knee Arthroscopy: 2017 Clinical Journal of Sports Medicine²⁶
 - *BFR: increases in thigh girth, 74.5% increase in strength vs 33.5%*
- PFPS: 2017 Br J Sports Med²³
 - *93% reduction in knee pain in BFR group at 8 weeks*
 - *Quad muscle thickness significant in HL-RT*
- Healthy population: 12 week strength training²²
 - *80% 1RM: 21.6% increase in strength*
 - *BFR: 20-40%1RM: 12.10% increase in strength*

TAKE HOME MESSAGE

- BFR promotes metabolic *environment* for strength/hypertrophy
- Start early (1-2 weeks post op) – reduce the degree of atrophy!
- Safe with proper screening
- Combine with NMES, biofeedback
- **Not a substitute to heavy resistance training**
- Fluctuate LOP to tolerance (80% is goal), reps to tolerance

Thank You!

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- 3: Dwight: <https://www.youtube.com/watch?v=nbGNFSB-xcQ>
- 4: Smart cuff: <https://www.smarttoolsplus.com/blood-flow-restriction-training/>
- 5: Edge: <https://edgemobilitysystem.com/products/edge-restriction-system-bfr-cuffs>
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