BLOOD FLOW RESTRICTION:
WHY YOU SHOULD BE USING IT

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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 & NWB\textsuperscript{14}
  - 5 days: Loss of Quad CSA >3%, Strength >9%
  - 14 days: Loss of Quad CSA >8%, Strength 22%

- Arthrogenic inhibition
  - 20 cc\textsuperscript{12,13}

- ACLR quad deficit 1 year post-op\textsuperscript{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 tear\textsuperscript{27}
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 proliferation\(^{34}\)

- **Blood lactate**\(^{32}\)
  - *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**\(^\text{28}\)
  - *Cell hydration (changing intra and extracellular pressure gradient)*

- **Mammalian target of rapamycin (mTOR)**\(^\text{28}\)
  - *Regulates muscle protein synthesis*

- **Vascular Endothelial Growth Factor (VEGF)**\(^\text{33}\)
  - *Angiogenesis, increased muscle hemoglobin*
HEAVY RESISTANCE TRAINING

- ACSM\textsuperscript{35}
- 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 Pressure\(^{10}\)
  - 80% LE
  - 50% UE
- Intensity: 20-40% 1RM\(^{11,17}\)
- Reps/sets: 4 sets, 30/15/15/15\(^{17}\)
- 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 recruitment\(^{32}\)
- Decreased joint loading
- Decreased muscle damage
- Use in combination with NMES\(^{18}\)
- Pain reduction\(^{37}\)
- Possible proximal gains: distal fatigue creates proximal recruitment?
RISKS

- **Thrombus**
  - “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:**
  - *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 pain\(^ {37} \)
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 & Exercise\textsuperscript{25}
  - 14 days post-op: Loss of CSA BFR (9.4%); control group (20.7%)

■ 2019 UK National Health Service\textsuperscript{21}
  - BFR: Y-balance, ROM, joint pain, effusion
  - Similar effects in knee extension/flexion torque, muscle thickness VL, pennation angle

■ 2019 Journal of Sport Rehabilitation\textsuperscript{40}
  - 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
ACLRT EVIDENCE cont.

- 2016 Journal of Sport and Health Science\textsuperscript{24}
  - 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 Medicine\textsuperscript{41}
  - 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 Medicine\textsuperscript{26}
  - \textit{BFR: increases in thigh girth, 74.5\% increase in strength vs 33.5\%}

- PFPS: 2017 Br J Sports Med\textsuperscript{23}
  - \textit{93\% reduction in knee pain in BFR group at 8 weeks}
  - \textit{Quad muscle thickness significant in HL-RT}

- Healthy population: 12 week strength training\textsuperscript{22}
  - \textit{80\% 1RM: 21.6\% increase in strength}
  - \textit{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!
REFERENCES

3: Dwight: https://www.youtube.com/watch?v=nbGNFSB-xQ
4: Smart cuff: https://www.smarttoolsplus.com/blood-flow-restriction-training/
7: KAATSU band pic: https://www.kaatsuperformance.com/Article.cfm?cms_ArticleID=281
8: Compressive: https://www.bfrshop.com


36: https://www.reddit.com/r/ACL/comments/dlj2iw/quad_atrophy/


