

Blood Flow Restriction

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OBJECTIVES



Understand the history of BFR

Explain the proposed physiological mechanisms behind BFR

Indications, Precautions, and Contraindications for BFR

BFR Exercise Protocol

History of BFR



- Development of BFR:
 - 1960s by Dr. Yoshiaki Sato
 - Initially used to strength train athletes
- Breaking into Rehab
 - 1990s following research showing potential for recovery
- Current use of BFR
 - Used in rehab, athletic training, etc
 - Used in athletes, geriatrics, adolescents, etc.

PHYSIOLOGY OF BFR



- Training method which **partially restricts arterial blood flow** and **fully restricts venous return** in muscles during exercise
- Primary Mechanisms:
 - Mechanical Stress
 - Metabolic stress
- Secondary Mechanisms
 - Systemic anabolic hormone production
 - Cell swelling → increased MPS and decreased proteolysis
 - Exercise Induced Muscle Damage?
 - Improved Type II fiber recruitment through anabolic pathways
- Increases MPS, myofiber size and muscle strength
 - Hypoxic environment = increased motor unit requirement
 - Fast twitch muscle fiber recruitment

BFR + REHAB

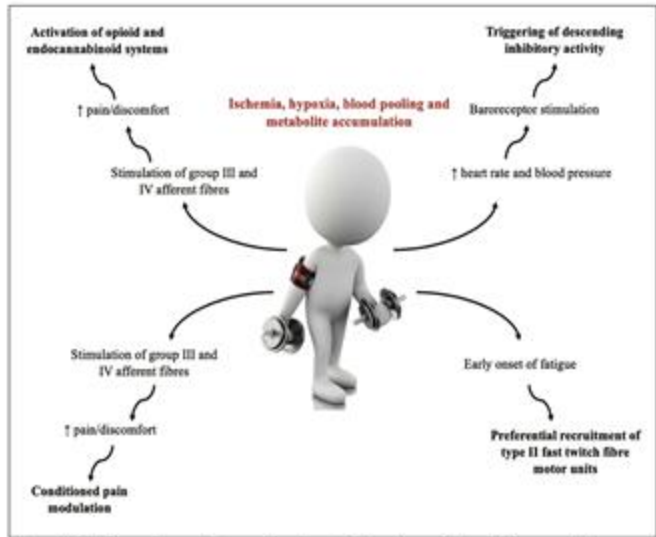


Figure 3.3. Proposed mechanisms for the analgesic effects of blood flow restriction.

- Metabolic stress allows for muscle growth with decrease in mechanical tension
- Promotes decrease in edema through reperfusion
- Inflammatory response promoting tissue remodeling
- Proposed pain reduction mechanisms
 - Stimulation of endogenous opioid production
 - Stimulation of the endocannabinoid system

INDICATIONS



- Prehab
- Post-surgical rehab
- Injury rehab (non-surgical)
- Chronic conditions/Acute on Chronic conditions
- Other indications:
 - Disuse atrophy
 - Low Bone Density

CONTRAINDICATIONS



Medications that increase clotting risk

Open fracture or soft tissue injury

Increased intracranial pressure

Unregulated HTN

Skin grafts

VTE

Peripheral vascular compromise

Dialysis (extremity with access)

Acidosis

Tumor distal to tourniquet

Sickle cell Anemia

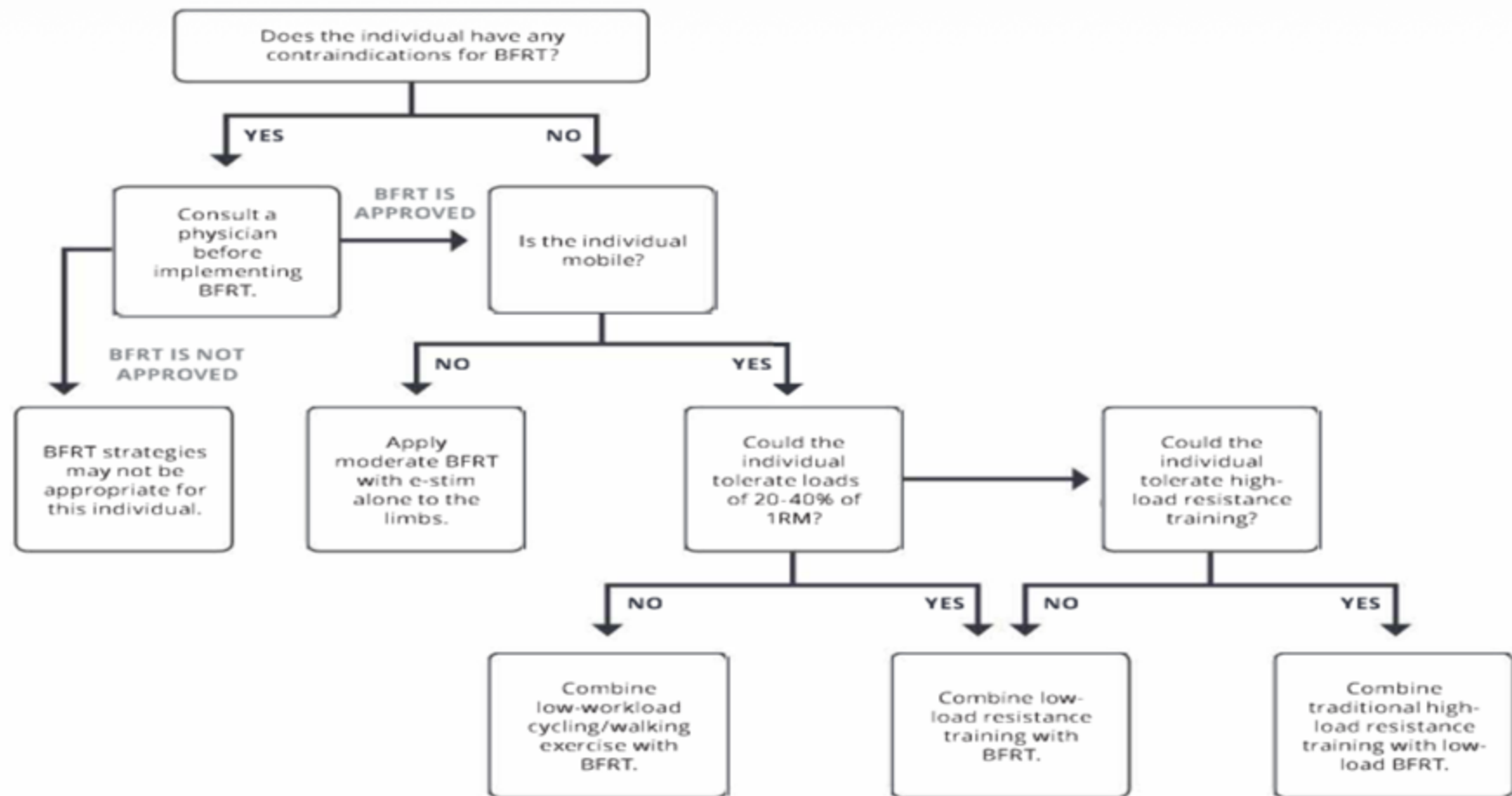
Infection

PRECAUTIONS

SAFETY CONSIDERATIONS



- Minimal risks unless you have administered to a patient who is contraindicated
- Possible adverse events:
 - DOMS
 - Increased perception of pain
 - Numbness/tingling in the occluded limb
- Possible rare adverse events
 - Rhabdomyolysis, acute vision loss, fainting or dizziness, petechial hemorrhage or venous injury, dermal capillary rupture, and syncope



**adopted from Dr. Jeremy Loenneke at the University of Mississippi

PRESSURE SETTINGS



UE: 50-60% LOP

LE: 60-80% LOP

EXERCISE PROTOCOL



- Typical training load for strength and hypertrophy adaptations: >65-70% 1RM
- BFR: 20-40% 1RM to maximize muscle change
- Repetitions: 1 set of 30; followed by 3 sets of 15
- Rest times: 30-60s
- Frequency: 2-3x/week
- Duration: 3-8 weeks

OTHER USES OF BFR



Cardiovascular exercise to improve VO_2 Max and aerobic capacity

Passive BFR immediately post-op to minimize atrophy

CONTRALATERAL LIMB EFFECT

- Literature suggests a “cross-over” effect with BFR training to the non-occluded limb
- It is suggested these effects are driven by neural adaptations and hormonal responses to the anabolic environment



BFR RESEARCH



Effects of a Perioperative Blood Flow Restriction Therapy Program on Early Quadriceps Strength and Patient-Reported Outcomes After Anterior Cruciate Ligament Reconstruction

Flow Restriction Therapy Preserves Lower Extremity Bone and Muscle Mass After ACL Reconstruction

Proximal, Distal, and Contralateral Effects of Blood Flow Restriction Training on the Lower Extremities: A Randomized Controlled Trial

Early- and Late-Stage Benefits of Blood Flow Restriction Training on Knee Strength in Adolescents After Anterior Cruciate Ligament Reconstruction

Effects of a Perioperative Blood Flow Restriction Therapy Program on Early Quadriceps Strength and Patient-Reported Outcomes After Anterior Cruciate Ligament Reconstruction

Method

- 46 patients, 22 in the BFR group and 24 in the control group
- RTC, patients did 2 weeks of prehab preoperatively, with the BFR group performing exercises with a pneumatic cuff set to 80% limb occlusion pressure placed over the proximal thigh. Afterwards, following standardized postoperative 12-week physical therapy protocol
- Quadriceps strength was measured
 - Peak and mean torque during seated leg extension
 - quadriceps index (percentage vs healthy limb)
- Patient-reported outcomes (PROs) gathered at 6 weeks, 3 months, and 6 months postoperatively along with,
 - knee range of motion
 - quadriceps circumference

Results: 6 weeks postoperatively

- BFR group had significantly greater strength when compared with the controls
- BFR group had significantly better Patient-Reported Outcomes Measurement

Flow Restriction Therapy Preserves Lower Extremity Bone and Muscle Mass After ACL Reconstruction

Method:

- A total of 32 patients undergoing ACLR with bone-patellar tendon-bone autograft were randomized into 2 groups (BFR and Control) and performed 12 weeks of postsurgery rehabilitation
 - Exercises: Quad contraction, CKC knee ext, B leg press, SL press, SLHS out, Ball squats, Split lunges, box step ups
- BFR group exercised under 80% arterial occlusion of the postoperative limb
- BMD, bone mass, and LM were measured using DEXA (iDXA, GE) at pre-surgery, week 6, and week 12 of rehabilitation

Results

- When compared to the BFR group, the CONTROL groups experienced
 - Decreased in LE mass at week 6 and week 12
 - Decreased LE bone at week 6 and week 12
 - Reduction in proximal tibia and proximal fibula
 - Loss of site specific BMD

BFR + Contralateral Limb Effects



Proximal, Distal, and Contralateral Effects of Blood Flow Restriction Training on the Lower Extremities: A Randomized Controlled Trial

Method:

- RTC participants in standardized 6-week course of BFR training. The protocol was completed by 26 patients, providing 16 BFR and 10 control patients

Results

- Increase in strength was seen proximal AND distal to the BFR tourniquet
 - 2x the improvement was seen in the BFR group compared with controls.
- Isokinetic testing
 - Increased knee extension peak torque, total work and average power
- Increase in thigh girth (0.8% vs 2.3%) and knee extension strength

BFR training had similar strengthening effects on both proximal and distal muscle groups.

Gains in the contralateral extremity may corroborate a systemic or crossover effect.

BFR + Adolescents



Early- and Late-Stage Benefits of Blood Flow Restriction Training on Knee Strength in Adolescents After Anterior Cruciate Ligament Reconstruction

Method

- Patients aged 12 to 18 years who underwent primary ACLR with a quadriceps tendon autograft
 - BFR 16 vs Control 16
- Peak torque values for isometric knee extension and flexion strength (at 3 months and RTS)
- Isokinetic strength at 180 deg/s (at RTS)
- Pediatric International Knee Documentation Committee (Pedi-IKDC) scores
- Used standardized BFRT protocol to a traditional rehabilitation protocol after ACLR significantly improved knee strength

Results

- RTS BFRT group showed higher isometric knee extension torque
- also reported significantly better Pedi-IKDC scores compared to the control group at both 3 months

BFR EQUIPMENTS



Owens Recovery System (Gold Standard!)

Smart Cuffs

Suji

BeStrong

Edge Mobility

DOES INSURANCE
COVER?

Nope!

LE Therapeutic Exercise Program with BFRT



Rehab/Prehab

Post-op (ACLR)

- Wk 0-6: Strength
- Wk 7-10: Endurance
- Wk 11-12: Heavy Eccentrics
- Wk 12-16: Power/speed
- Wk 16+: Power/speed

REHAB OR PREHAB



Protocol/Rep Scheme:

- 80% of total LOP
- 3-4 exercises with BFRT
- 30-15-15-15 reps
- 4x a week

Wk 1: quad activation (SLR), Proximal strengthening, mobility/ROM, CKC strengthening (DL squats/STS/DL RDL)

Wk 2-3: Progress load with DL squats/Deadlifts, introduce split stance squats, continue mobility/ROM and proximal muscle strengthening

Wk 4: Continue progressive loading with DL/split squats/deadlifts, introduce SL strengthening (SL RDL/SL bridge), continue mobility/ROM

LE POST OP : 0-6 WEEKS STRENGTH



POD 3-4: **100% total LOP** (limb occlusion pressure), **5 min x 3**

Wk 0-2: 80% of total LOP, 30-15-15-15 reps

- quad activation (quad sets), ankle pumps, mobility/ROM

Wk 3-4: 80% of total LOP, 30-15-15-15 reps

- Wt bearing/shifting (TRX, parallel bars or EOB), gait training, biking

Wk 5-6: 80% of total LOP, 30-15-15-15 reps

- CKC loading/wt bearing, introduce split stance or SL activities

LE POST OP : 7-10 WKS ENDURANCE



BFR Protocol/Rep Scheme:

- 80% of total LOP, 30-15-15-15 reps

High Reps

- Concentric loading
- Exercises: Leg press, DL Squats, LAQ or Step ups

Reduced Reps

- Eccentric loading
- Exercise: DL squat holds, Bulgarian split squats, SL RDL, step downs or wall leans

LE POST OP : 11-12 WKS ECCENTRIC HEAVY



PAUSE BFR

Eccentric LE Loading

- Increase knee strategy and load with HEAVY eccentrics

Exercises

- 3-4w step downs, depth DL squats, Front squats, goblet squats

LE POST OP : 12-16 WKS POWER/SPEED



Reincorporate BFR

- Helps reduce soreness with light loads with heavy load benefits
- Does not need to be used every session, instead incorporate into program
 - Ideally low load days

Deceleration exercises

Acceleration exercises

LE POSTOP:

16+WKS

POWER/SPEED



Reincorporate BFR

- Warm ups to increased fast twitch muscle recruitment

Exercises:

Running, change of direction or DL jumps

LAB



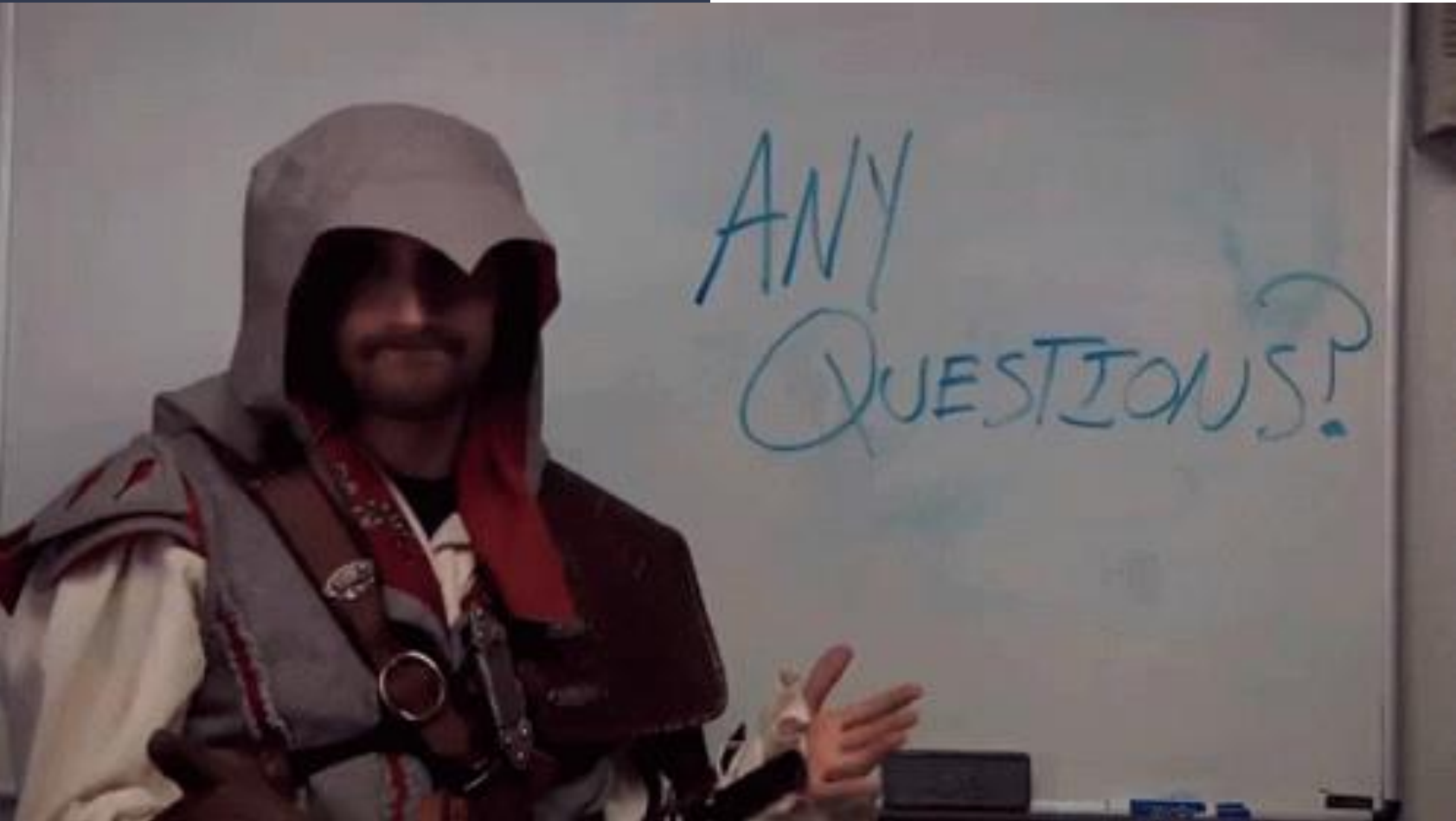
Grab a Partner and a Smartcuff BFR device

LE:

- Placement: L or R thigh
- Patient position: Supine
- Calibrate - personalize (determines total LOP and deflates)
- Based on Patient's LOP, set device to 80% of total LOP
- Rep Scheme: 30-15-15-15

UE:

- Placement: L or R arm (Near axial)
- Patient position: Supine or seated
- Calibrate - personalize (determines total LOP and deflates)
- Based on Patient's LOP, set device to 50% of total LOP
- Rep Scheme: 30-15-15-15



ANY
QUESTIONS?

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