MATA LEARNING LAB

BLOOD FLOW RESTRICTION IN SPORTS MEDICINE

Blood Flow Restriction in Sports Medicine

Braidy Solie, DPT,SCS, CSCS

Today's Agenda

Part 1: BFR Overview Lecture

- Braidy Solie, DPT

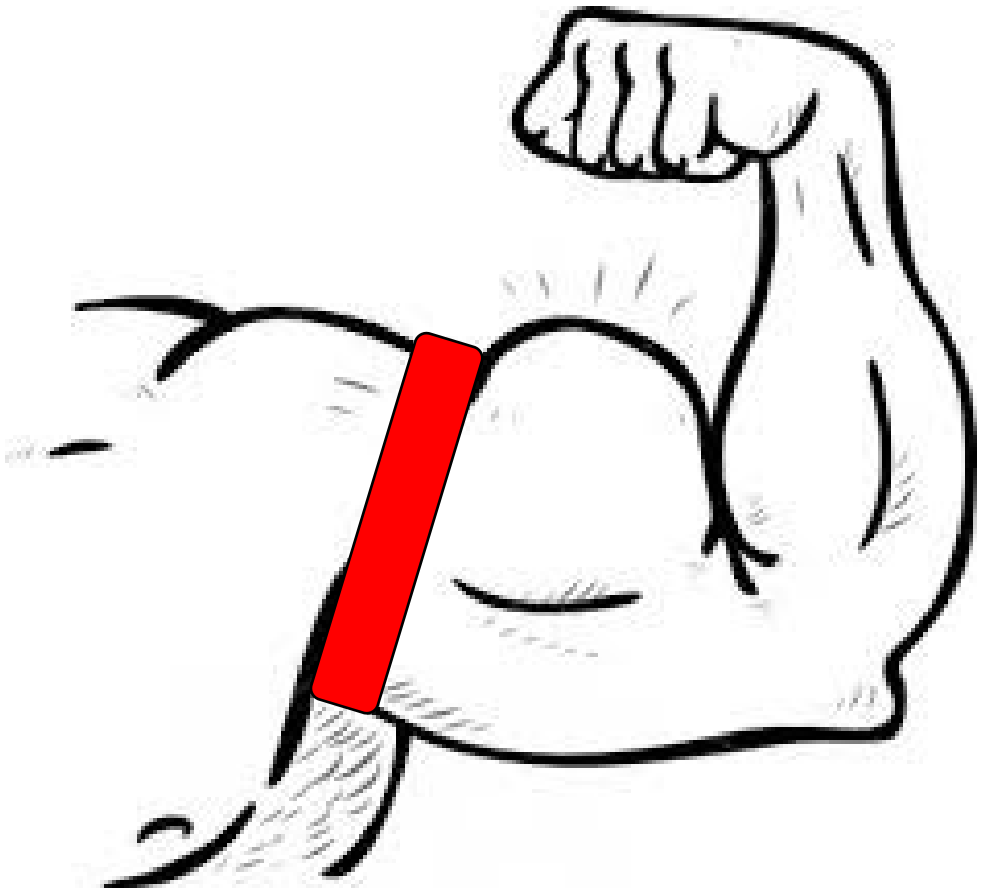
Part 2: BFR Learning Lab

- Braidy Solie, DPT
- Chee Vang, DPT

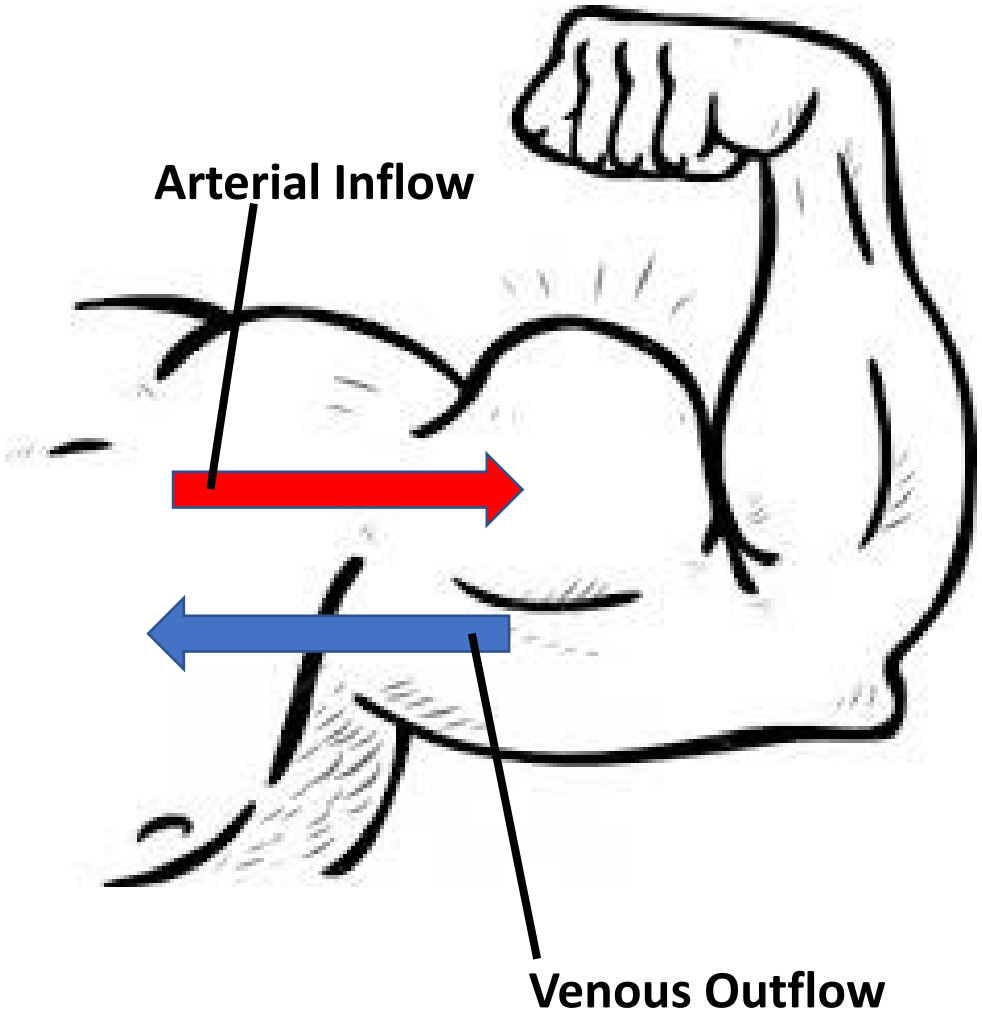
Part 1: BFR Overview Lecture

Provider Disclaimer

- I have no conflicts of interest, commercial support, or financial disclosure
- I am in compliance with continuing education requirements
- Use discretion when interpreting the views and information within these slides

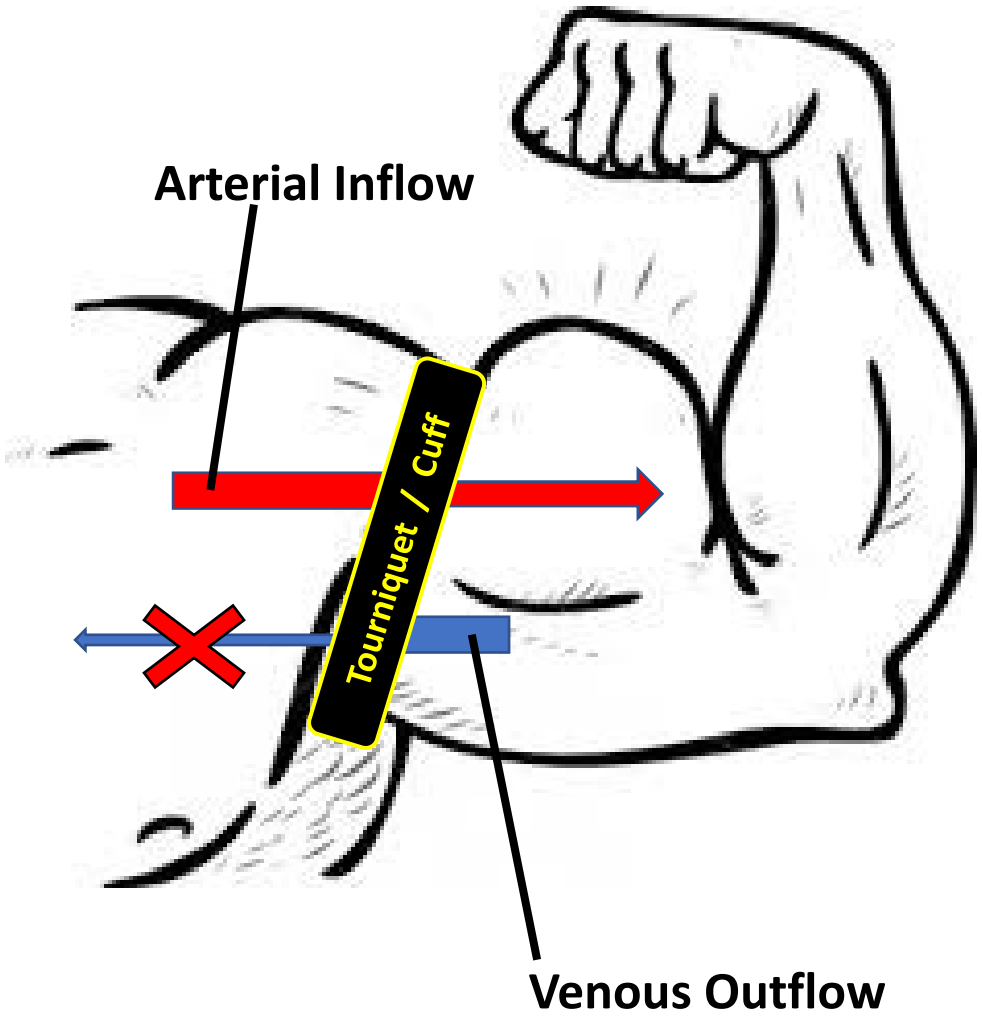


Exercise with Blood Flow Restriction



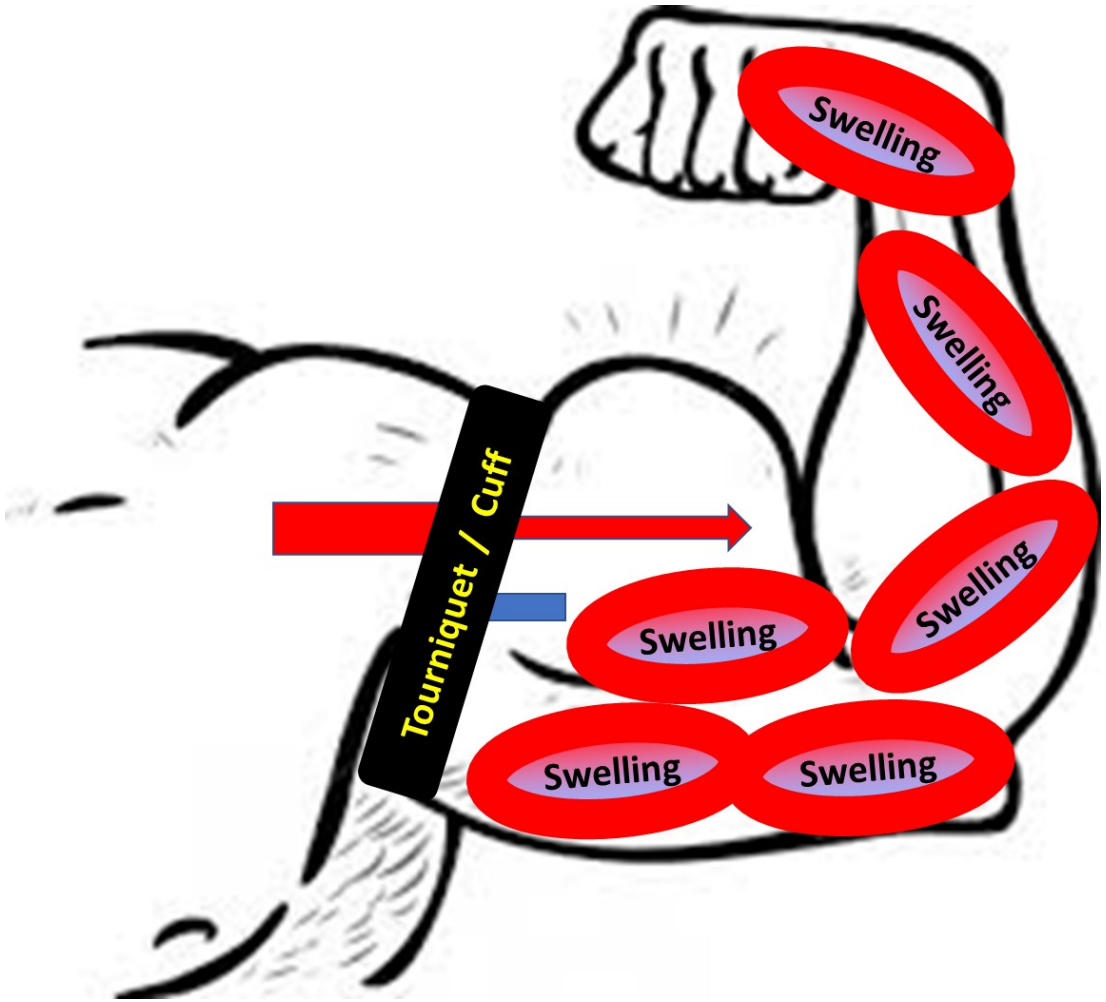
“Normal” Exercise

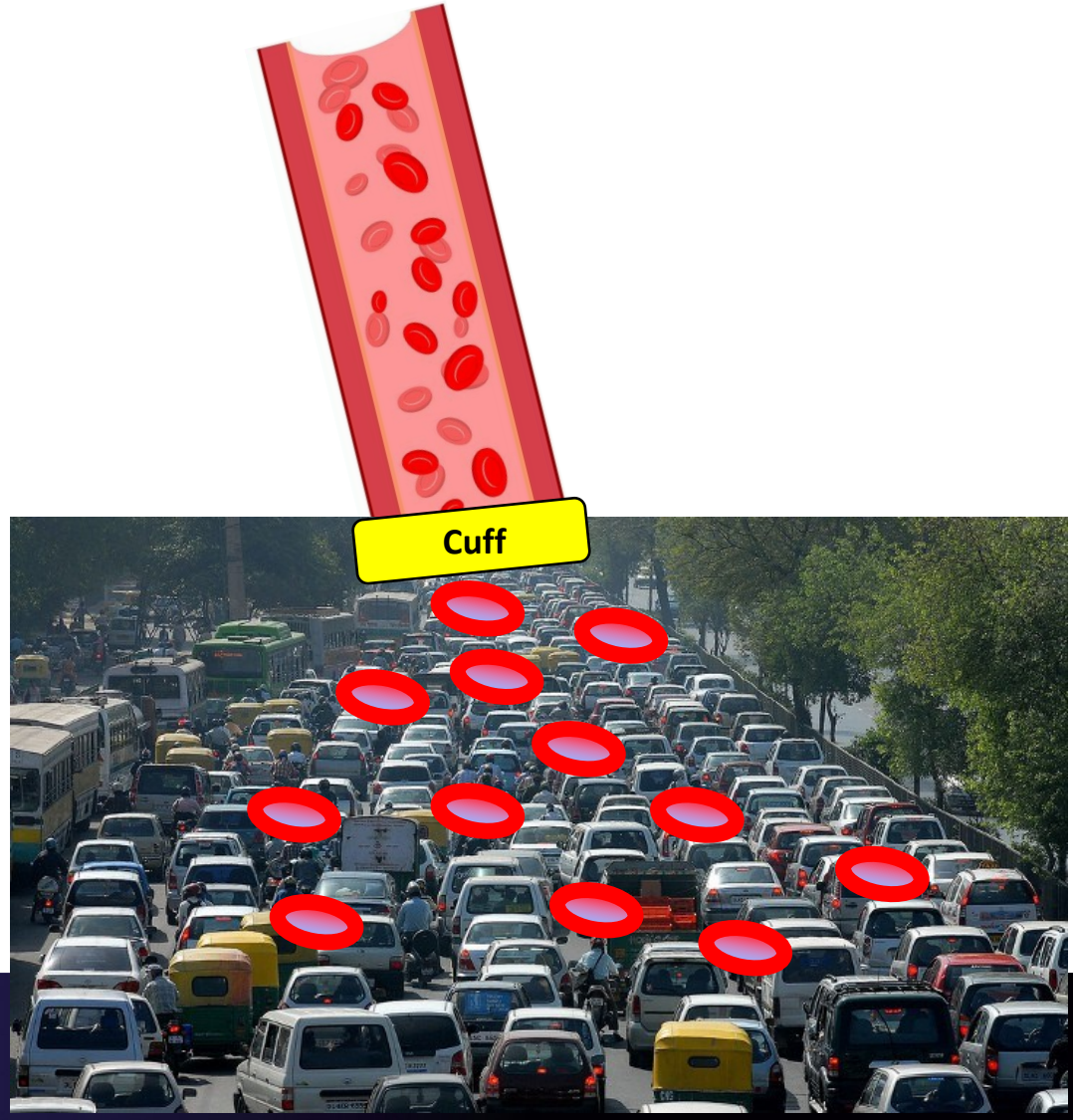
Blood Flow Restriction (BFR)



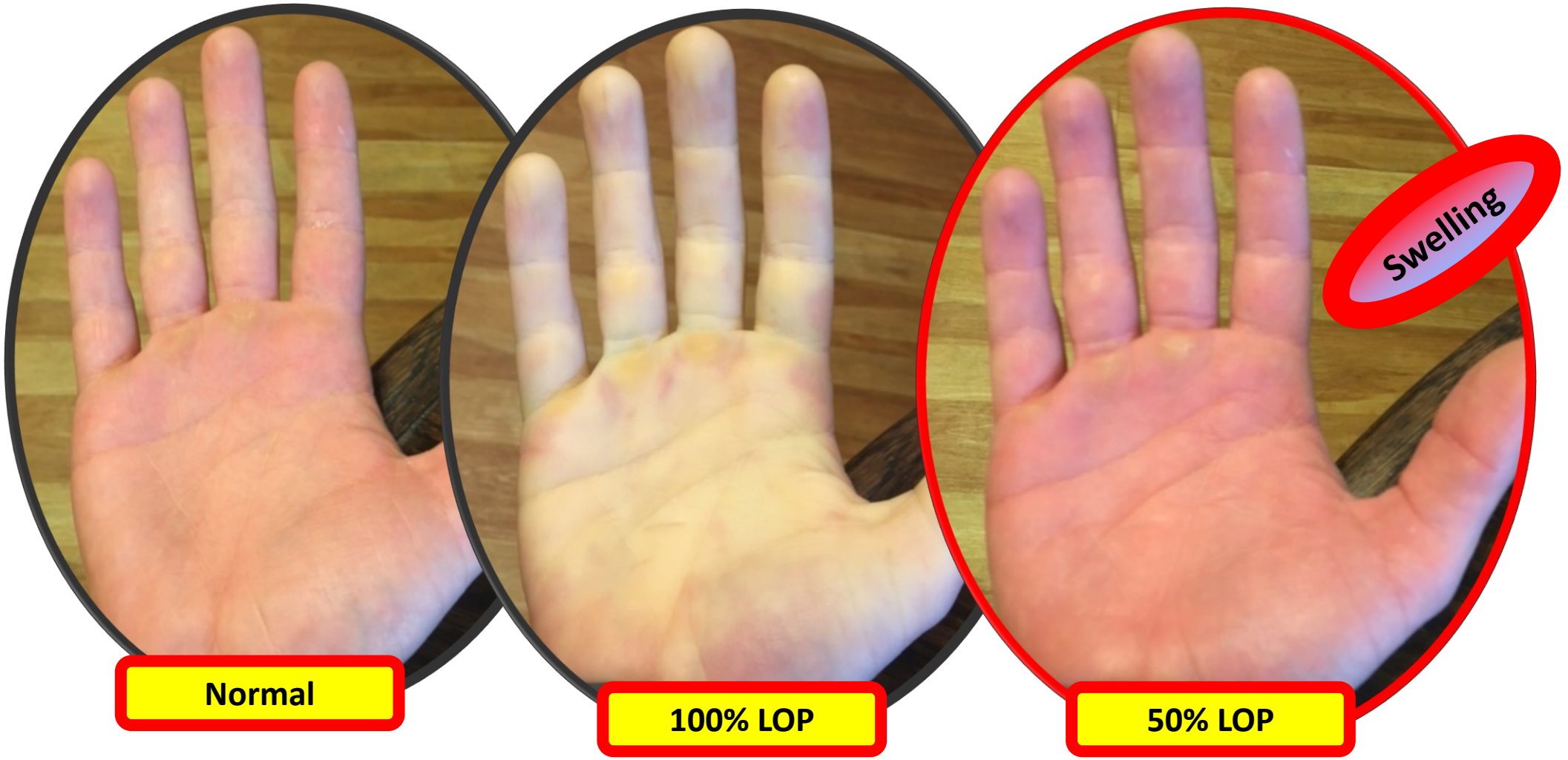
30-80% Arterial Occlusion Pressure

Venous Backup

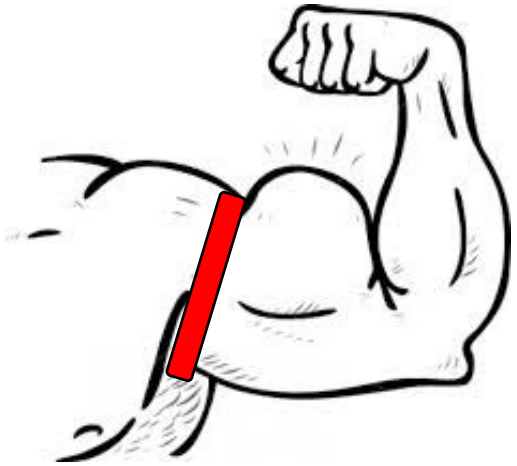


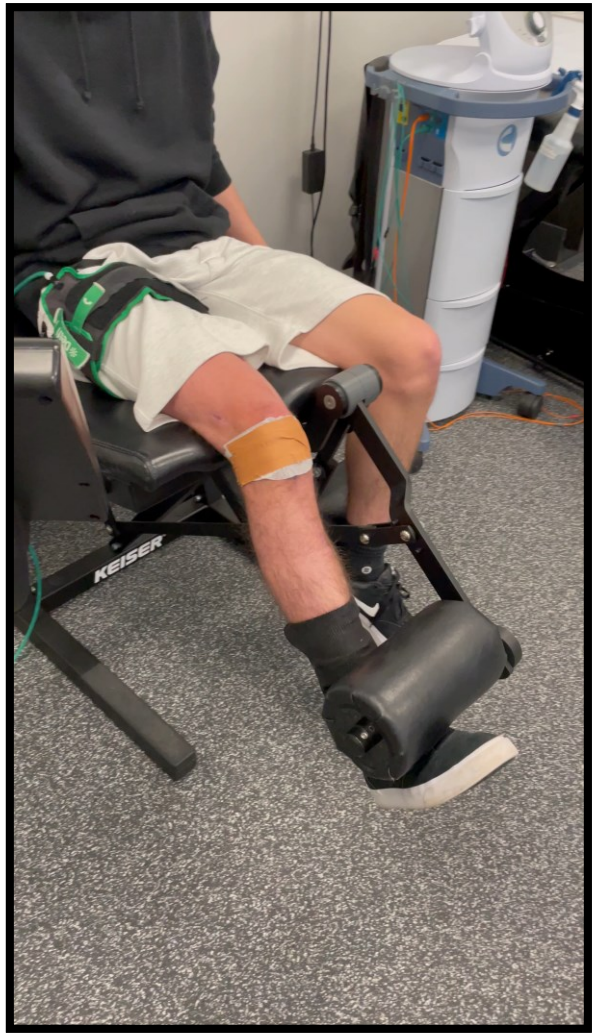


Blood Flow Restriction

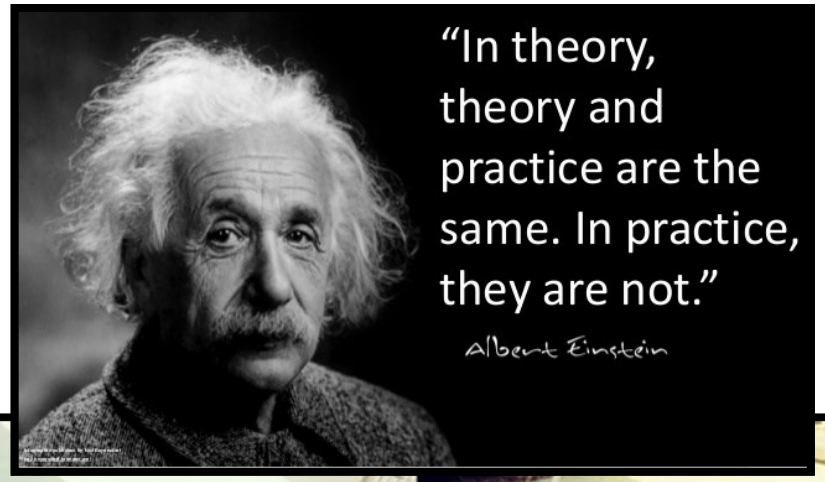


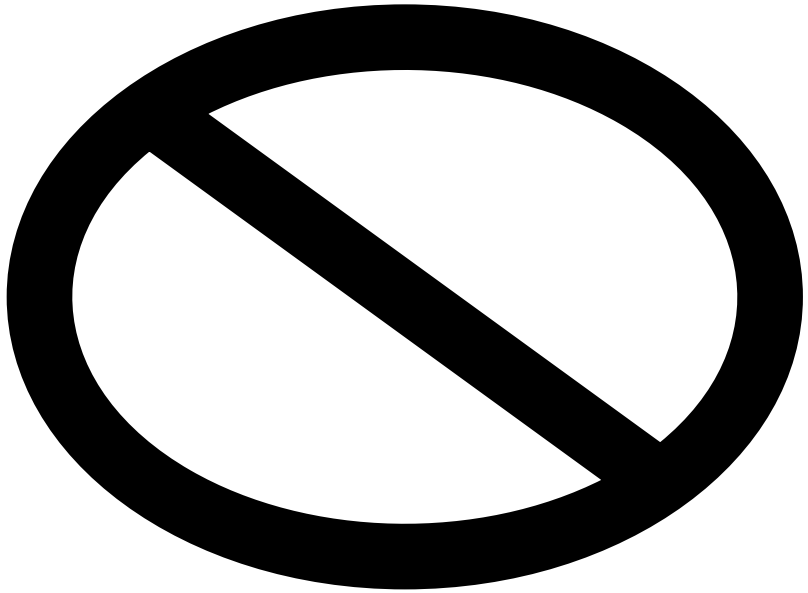
BFR after ACLR





Evidence-~~Based~~ Informed Practice





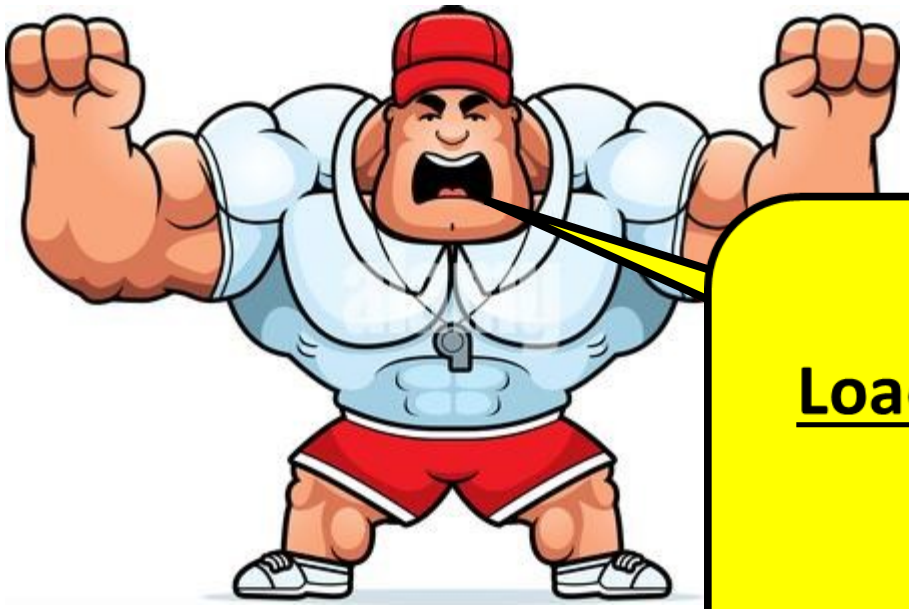

Theory/Research
Practice

Prescribing in Practice

Load: "Irritability/Tolerance/Patient"

Cuff Pressure: "Is Perfect Pressure a Must?"

Sets/Reps: "What is Most Efficient?"



Prescribing in Practice

Load: "Irritability/Tolerance/Patient"

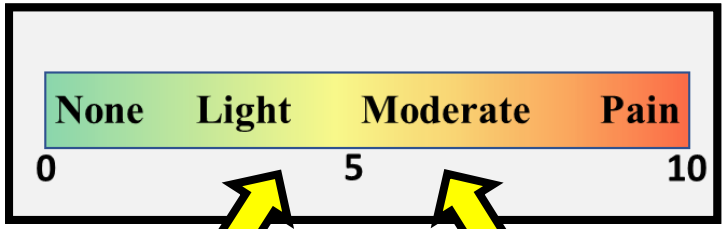
TWIN CITIES ORTHOPEDICS

TRAINING HAUS

Prescribing in Practice

Load: "Irritability/Tolerance/Patient"

Pain Monitoring



Stage of Tissue Healing ⟷ Rate of Perceived Exertion (RPE) Scale

Prescribing in Practice

~~**Load: "Irritability/Tolerance/Patient"**~~

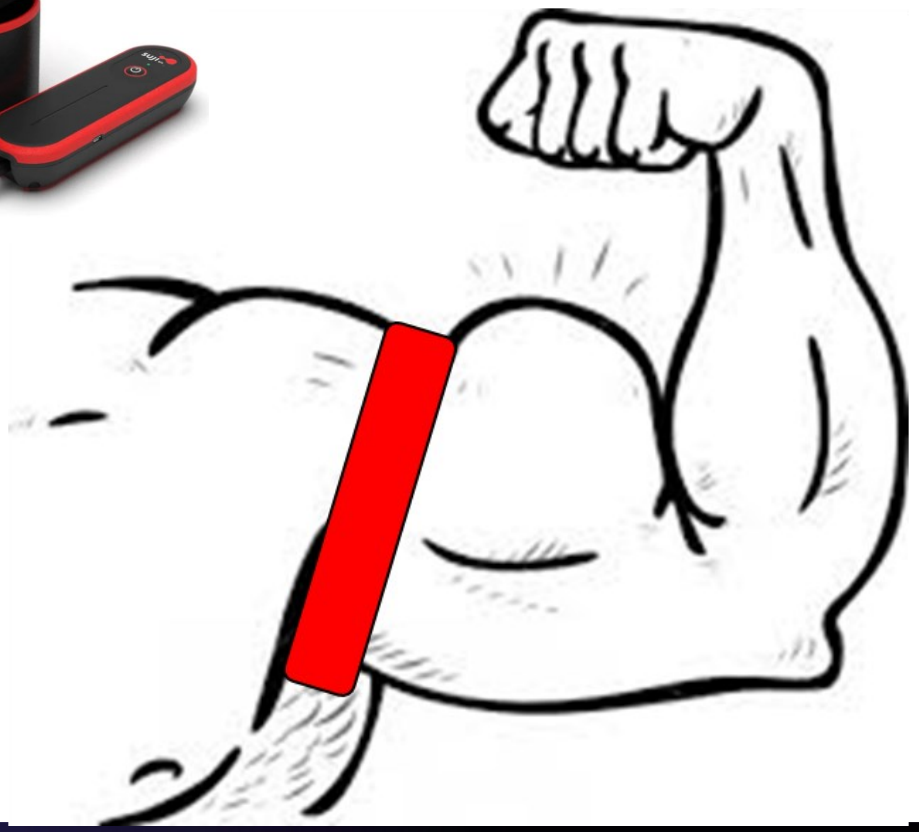
Cuff Pressure: "Is Perfect Pressure a Must?"

Administering BFR

Arbitrary Pressure	150-200mmHg
% Arterial Occlusion	30-100% Arterial Occlusion
% Systolic Blood Pressure	130% Systolic
Blood Pressure + Limb Girth Equation	Pressure = (Thigh Girth) + 0.7 (Diastolic) + 0.9 (Systolic) – 220
Rate of Perceived Tightness	7-8/10 Tightness

Lorenz et al. *JAT* (2021)

Perfect Pressure?



52 BFR Studies

Valenzuela et al[30]
Reis et al[32]
Petrick et al[33]
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Araújo et al[49]
Laurentino et al[50]
Laurentino et al[51]

REVIEW ARTICLE

WILEY

Is there rationale for the cuff pressures prescribed for blood flow restriction exercise? A systematic review

Matthew J. Clarkson | Anthony K. May | Stuart A. Warmington

Clarkson et al. SJMSS (2020)

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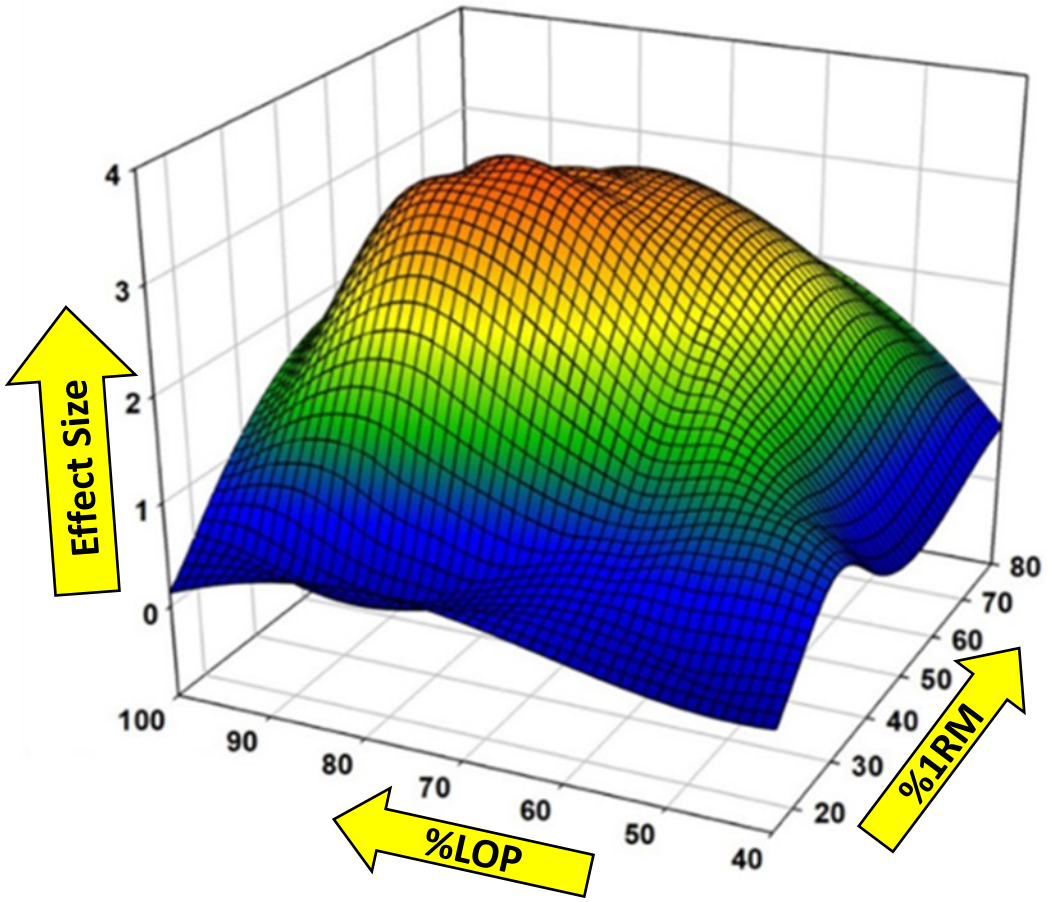
applied within the literature. Even more problematic is the absence of any clear justification for the selected BFR pressures in the vast majority of BFR exercise studies. Given the

No science for exact cuff pressures…..

Perfect Pressure?..

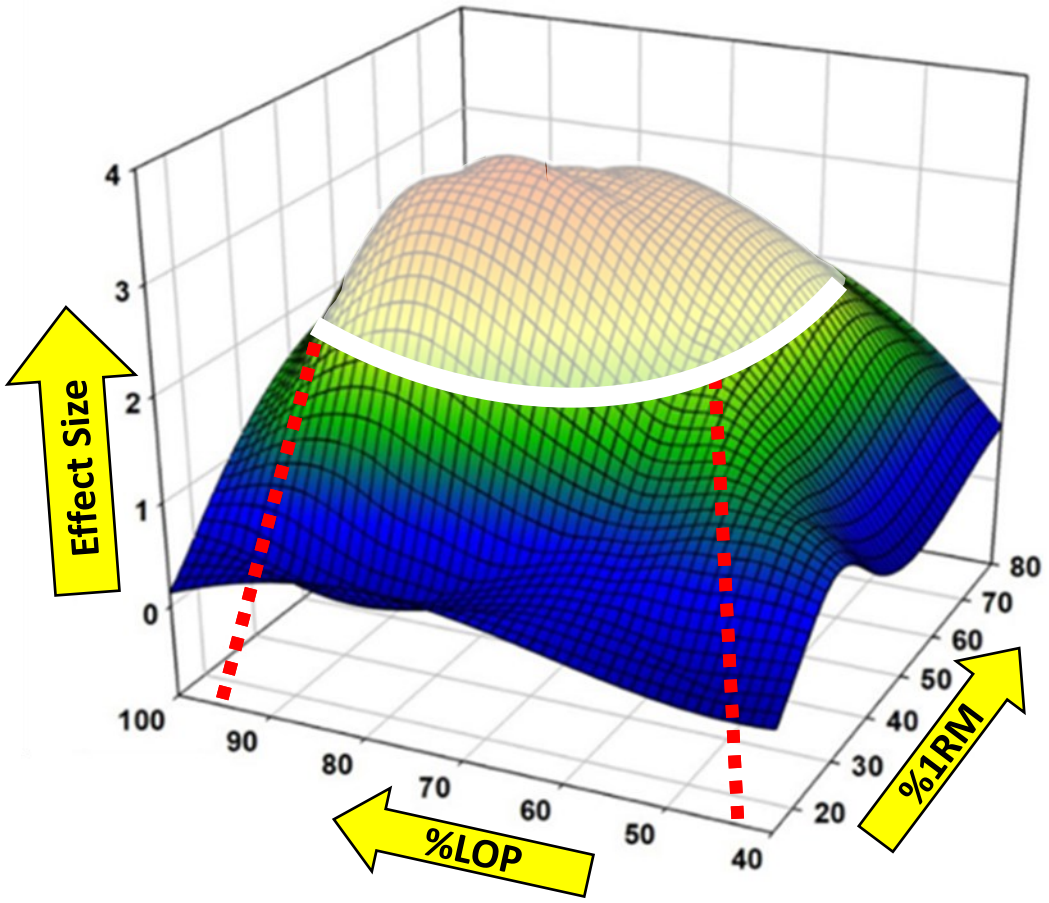


Is There a Minimum Effective Dose for Vascular Occlusion During Blood Flow Restriction Training?

Arpan Das and Bruce Patons**

Das, Arpan, and Bruce Paton. *Frontiers in physiology* (2022)

Perfect Pressure?.. Not Really



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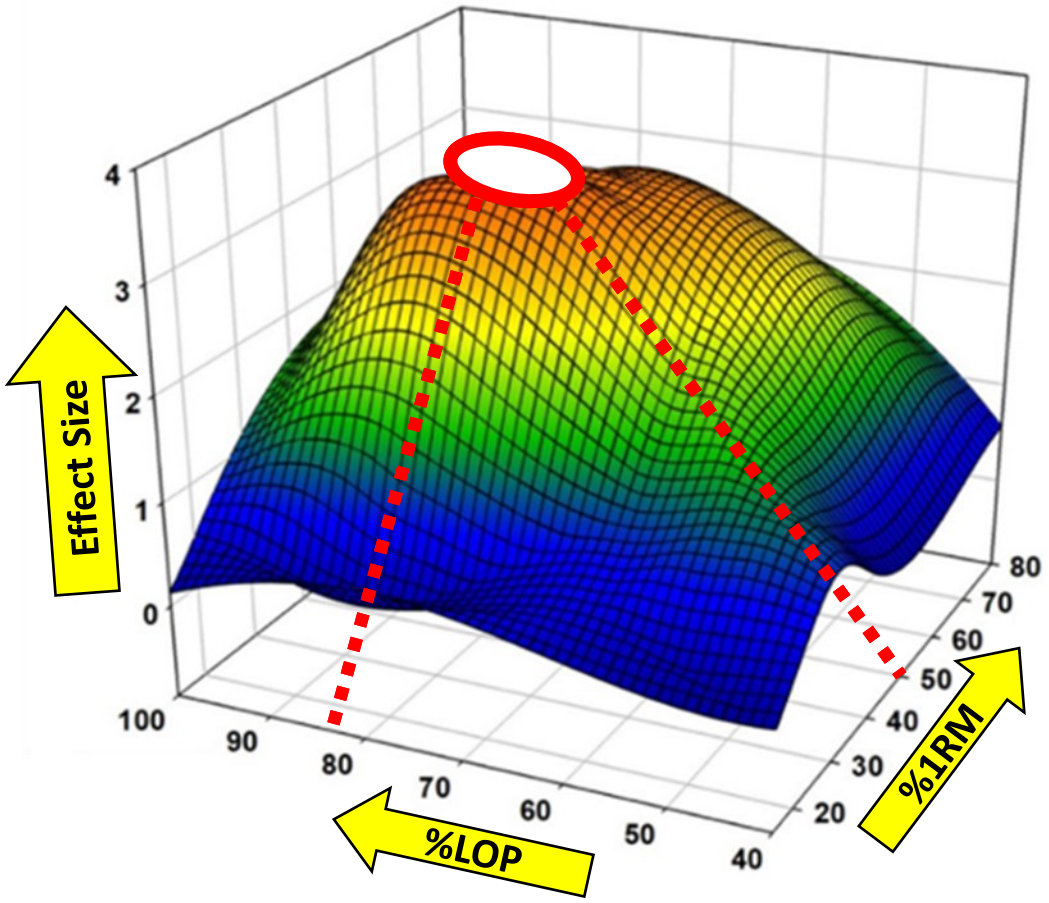
Large Therapeutic Window

<40% - 100% LOP

Perfect Pressure?.. Not Really



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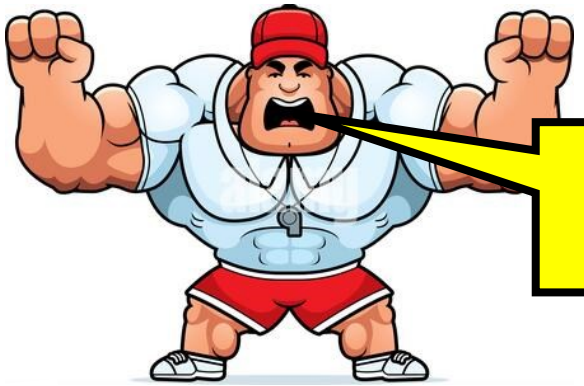
Largest Effect

%LOP: 70-95%

%1RM: 40-70%

Perfect Pressure?.. Not Really



Load is **more important** than **pressure**!

Is There a Minimum Effective Dose for Vascular Occlusion During Blood Flow Restriction Training?

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Pressure-Load Interaction

Effects of exercise intensity and occlusion pressure after 12 weeks of resistance training with blood-flow restriction

Manoel E. Lixandrão[1] · Carlos Ugrinowitsch[1] · Gilberto Laurentino[1] · Cleiton A. Libardi[2] · André Y. Aihara[3] · Fabiano N. Cardoso[3] · Valmor Tricoli[1] · Hamilton Roschel[1]

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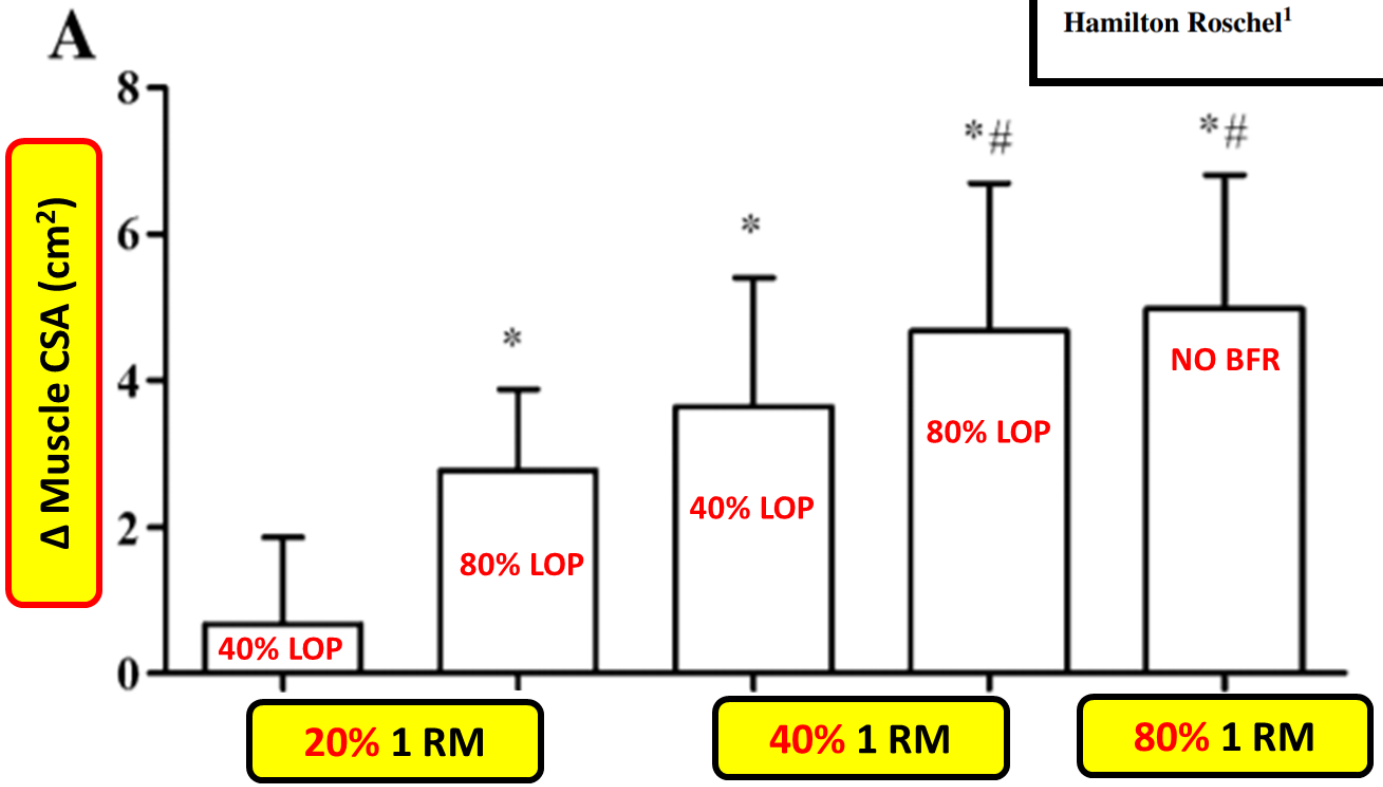

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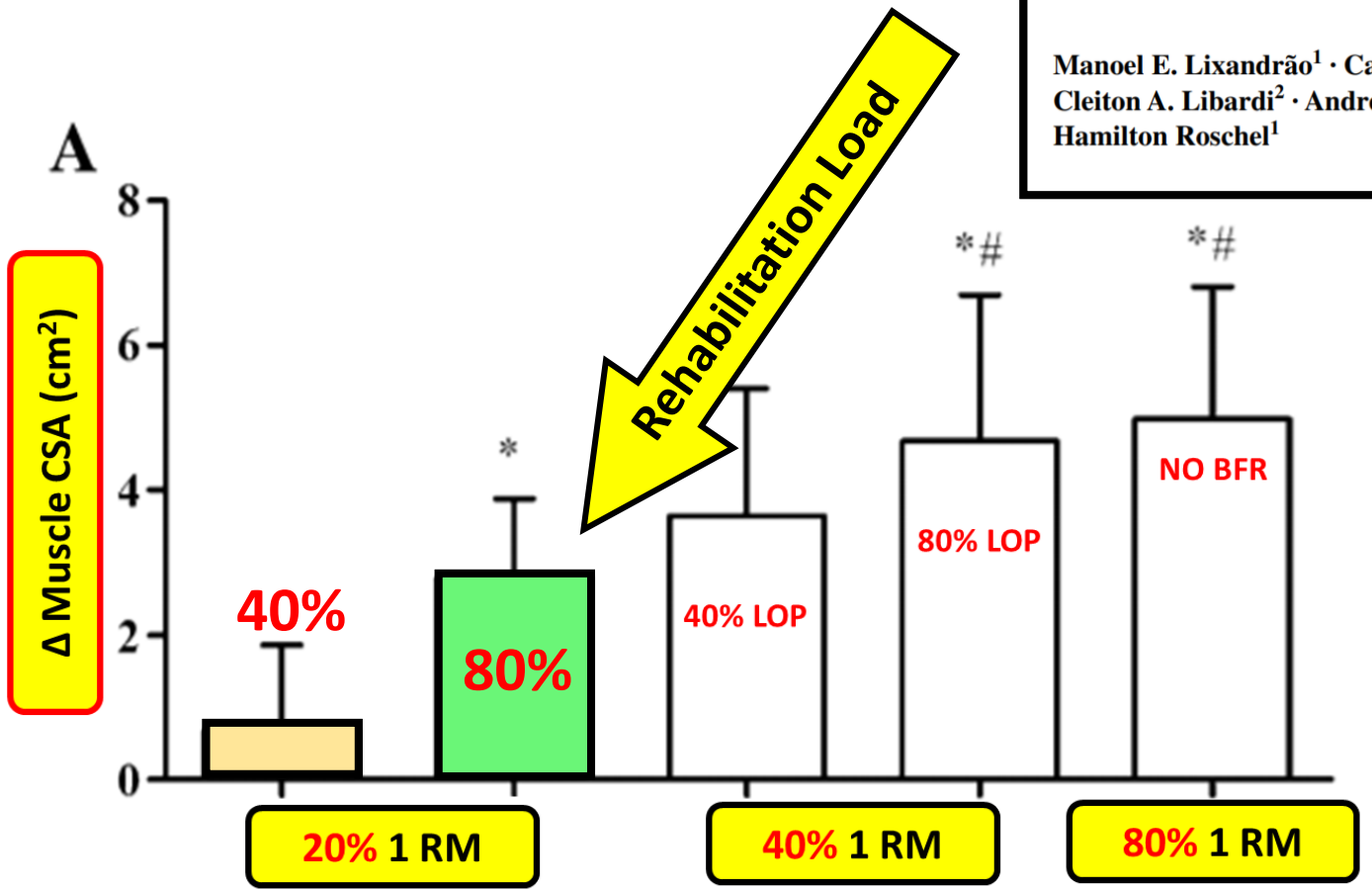
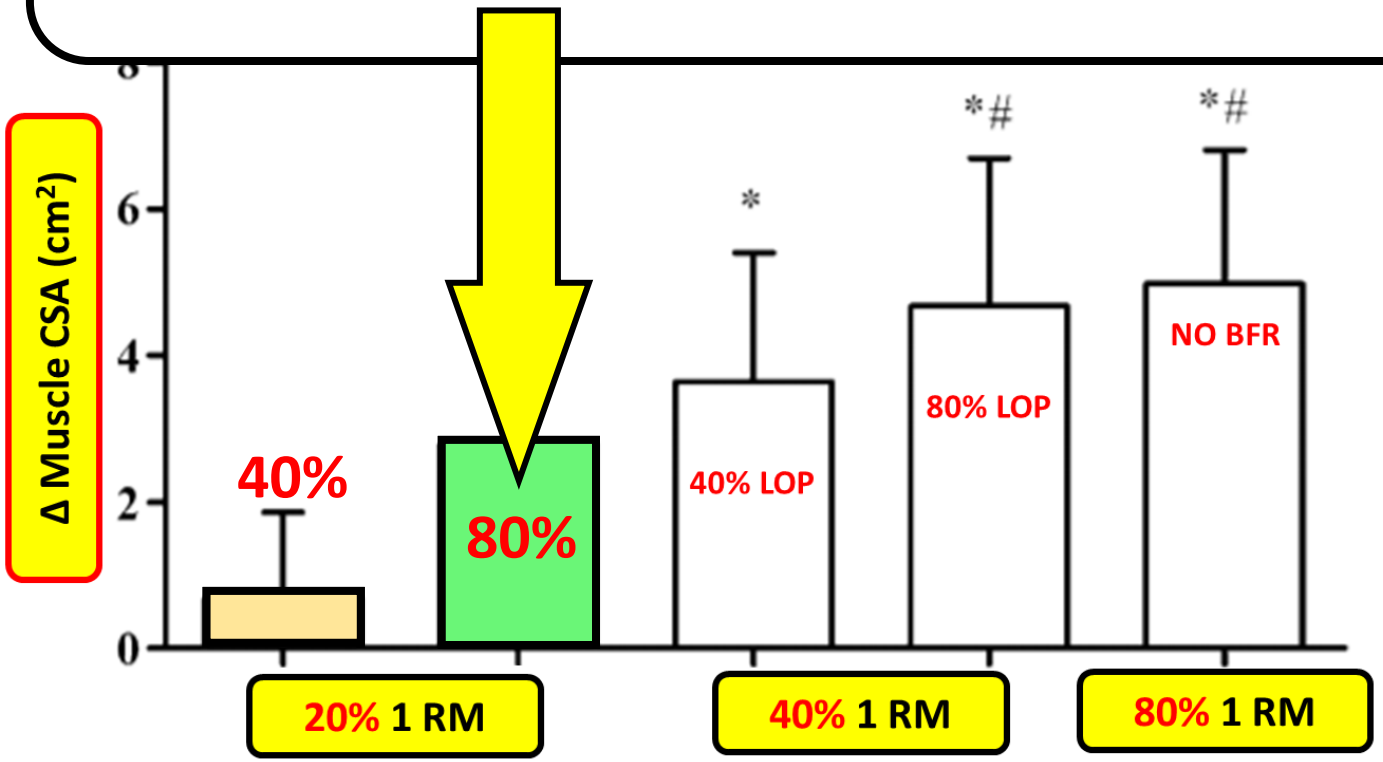


Pressure-Load Interaction

Higher occlusion pressures are beneficial with **low intensity exercise.**



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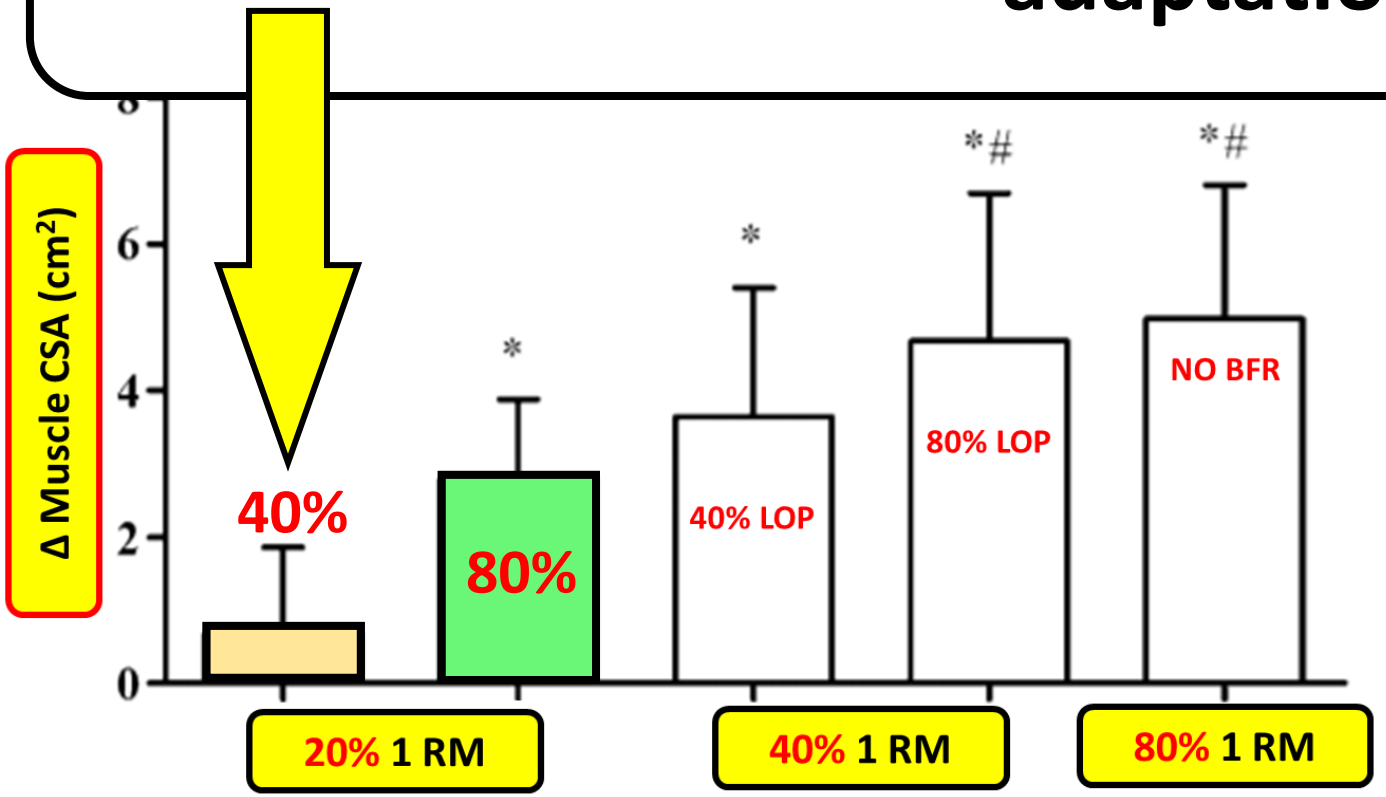
Pressure-Load Interaction

Low Pressures will still produce some beneficial adaptation.



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Prescribing in Practice

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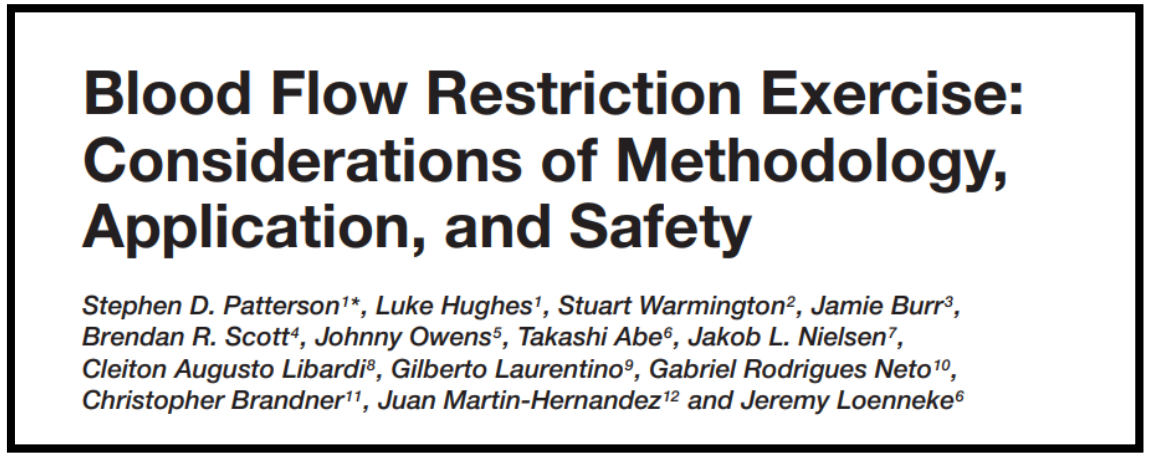
Sets/Reps: "What is Most Efficient?"

BFR Dosing



Blood Flow Restriction Exercise: Considerations of Methodology, Application, and Safety

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Patterson et al. Front Physiol (2019)

Research Protocol

2-4 Exercises/Muscle Group

4 Sets of 30, 15, 15, 15

(30 seconds rest between sets)

BFR Dosing

Blood Flow Restriction Exercise: Considerations of Methodology, Application, and Safety

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~~Research Protocol~~

Not Clinic Friendly

4 Sets of 30, 15, 15, 15

(30 seconds rest between sets)

Hypertrophy Rep Range Myth

Grgic. JSSH (2021) | Morton. Cur Op Physio (2019)
Leonneke. ACSM (2019) | Dankel. Sport Med (2017)

Training to Fatigue: The Answer for Standardization When Assessing Muscle Hypertrophy?

Scott J. Dankel[1] · Matthew B. Jessee[1] · Kevin T. M...
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ELSEVIER

Training for strength and hypertrophy: an evidence-based approach

Robert W Morton[1], Lauren Colenso-Semple[2] and Stuart M Phillips[1]

Original article

Effects of resistance training performed to repetition failure or non-failure on muscular strength and hypertrophy: A systematic review and meta-analysis

Jozo Grgic[a], Brad J. Schoenfeld[b,*], John Orazem[c], Filip Sabol[d,e]

[a] Institute for Health and Sport (IHES), Victoria University, Melbourne 3011, Australia
[b] Department of Health Sciences, Lehman College, Bronx, New York 10468, USA

Myth - Fake News - Myth - Not True - Myth - Outdated

50 Reps

20 Reps

12 Reps

8 Reps

TWIN CITIES ORTHOPEDICS | TRAINING HAUS

Hypertrophy Rep Range

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50 Reps

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TWIN CITIES ORTHOPEDICS | TRAINING HAUS

Hypertrophy = Close to Failure

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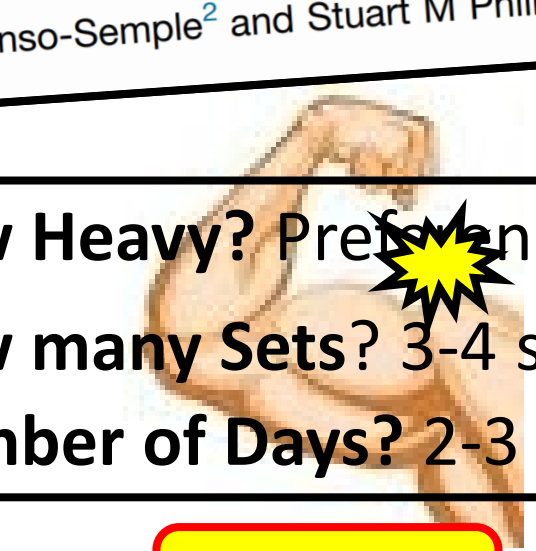


20 Reps

How Heavy? Preference

How many Sets? 3-4 sets to **Failure**

Number of Days? 2-3 Days/Week

12 Reps

8 Reps

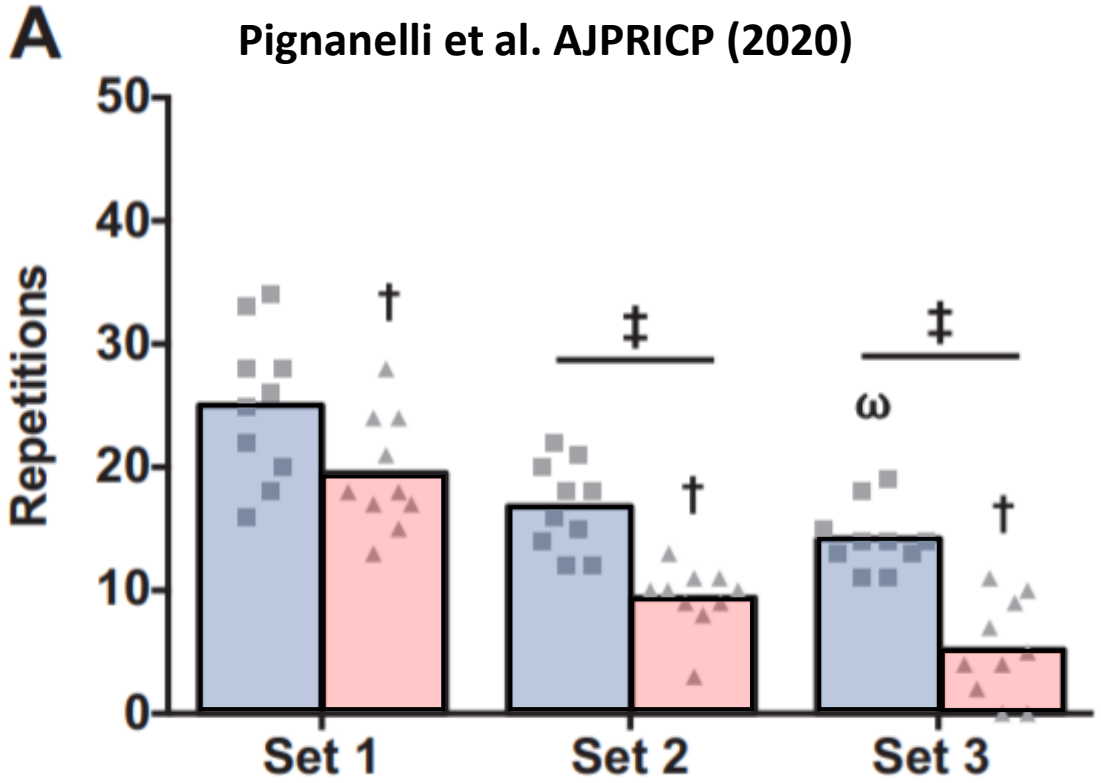
TWIN CITIES ORTHOPEDICS | TRAINING HAUS

Training to Failure with/without BFR

RESEARCH ARTICLE | *Physical Activity and Inactivity*

Low-load resistance training to task failure with and without blood flow restriction: muscular functional and structural adaptations

Pignanelli et al. AJPRICP (2020)



BFR

Control

Training to Failure with/without BFR

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BFR

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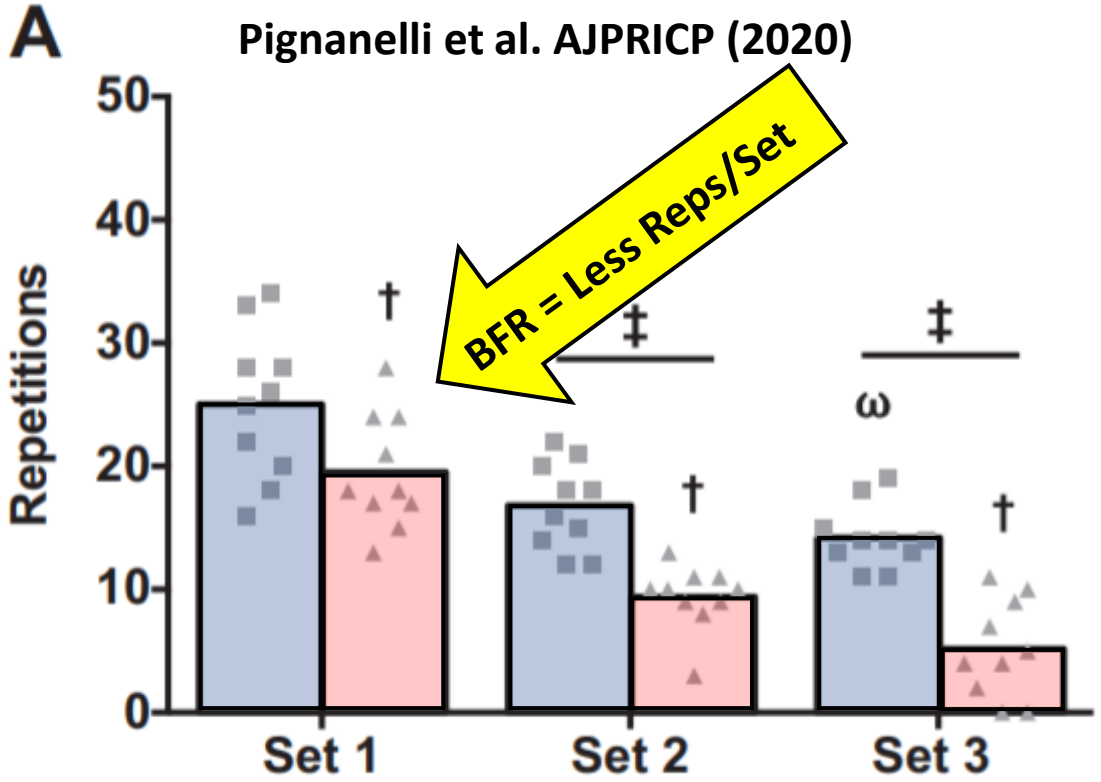
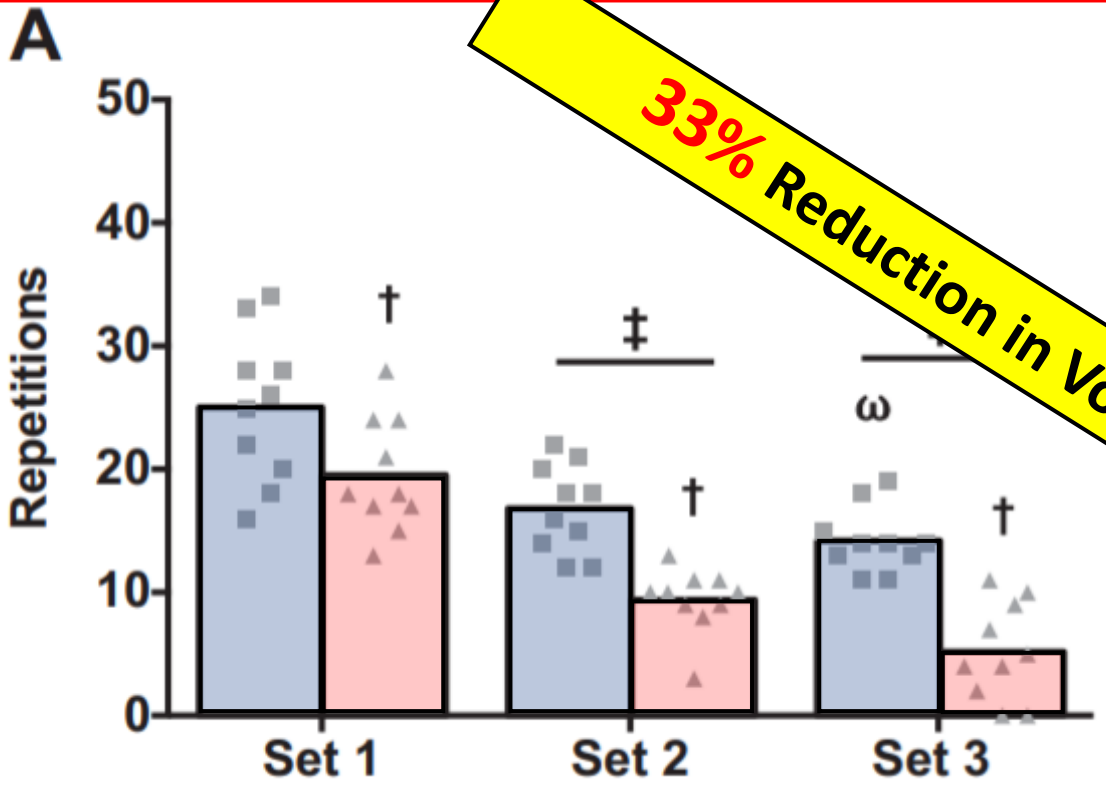


Training to Failure with/without BFR

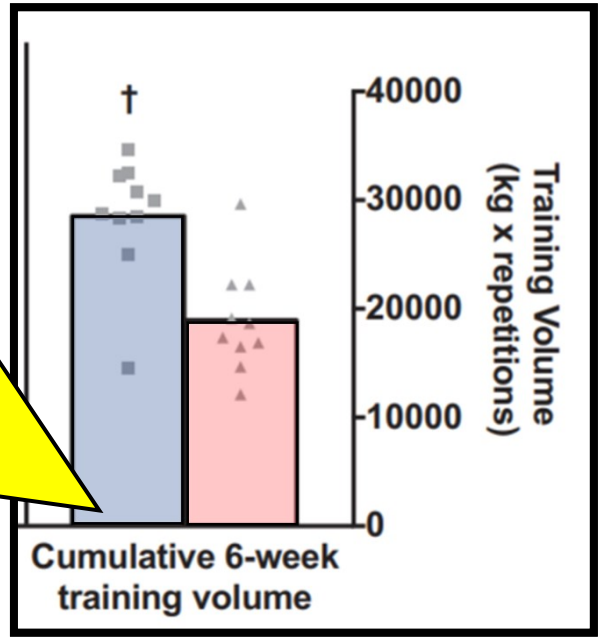
BFR Causes Set Failure….Faster



33% Reduction in Volume

BFR

Control



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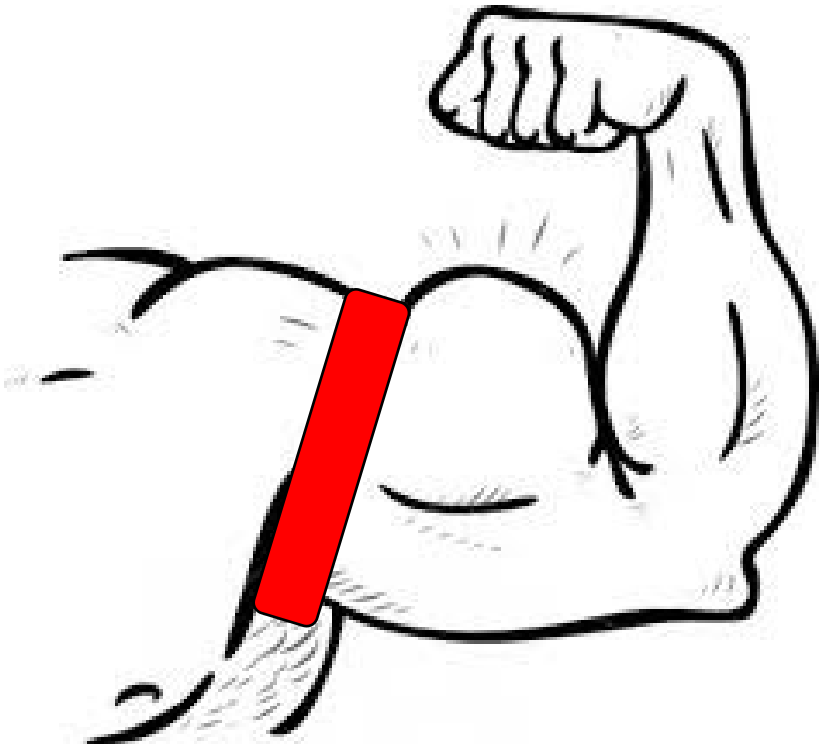
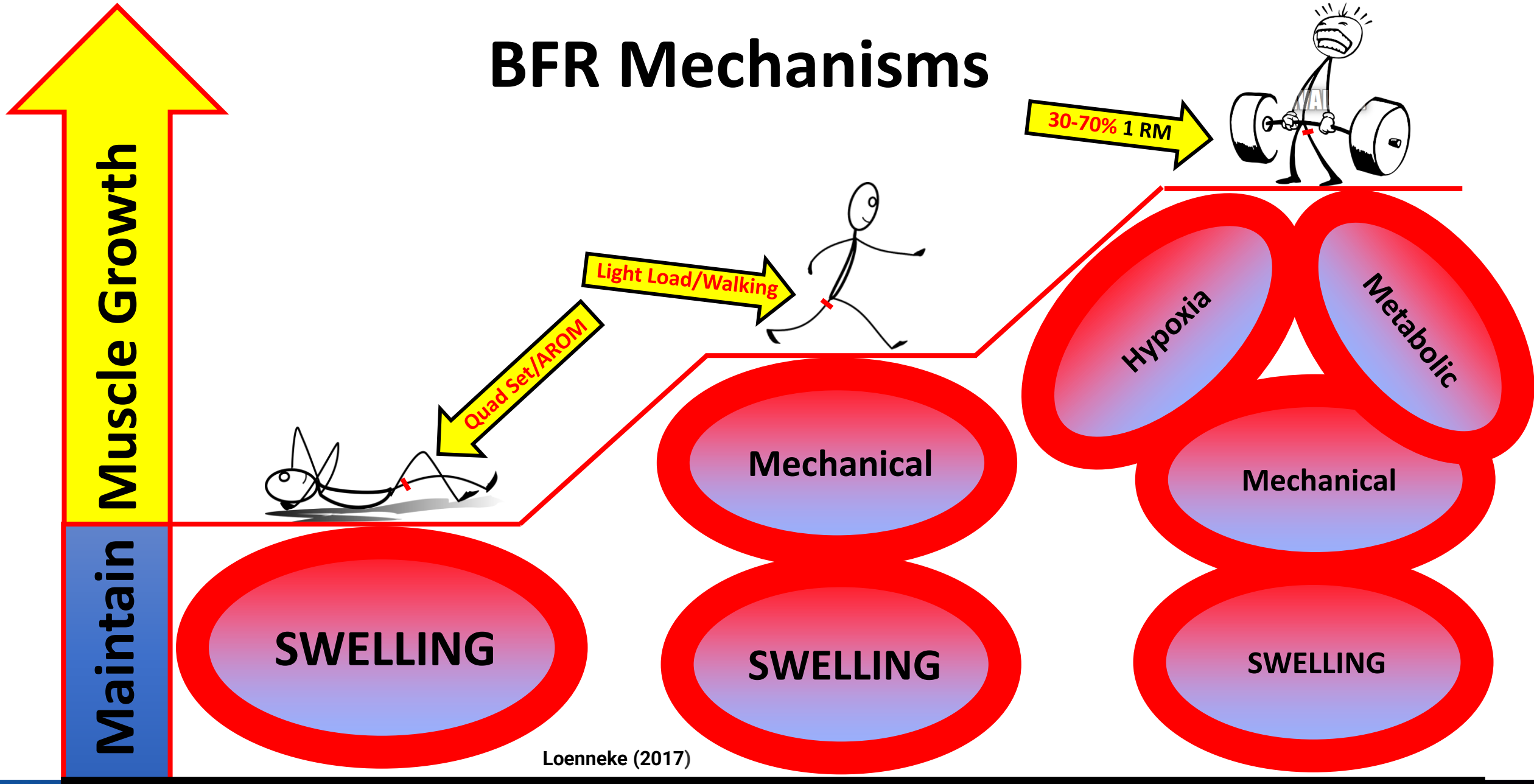


BFR Mechanisms



Loenneke (2017)

Cell Swelling Mechanism

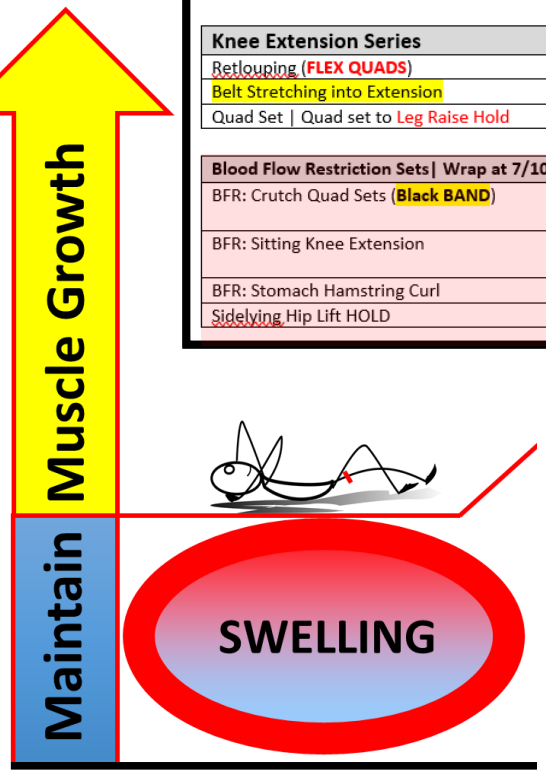
[redacted] | ACL | Dr. Larson | Lacrosse

MedBridge Code: Z2VKGPMC

Activity	Sets/Reps	Exercise Recommendations and Details to Focus On
Symptom management		
Icing	20-30 min on| 30 min off	Do not over ice your skin
Incrediwear Sleeve		**At all times as tolerated** (do ankles pumps often
Resting Position	Pillow under **calf NOT knee**	Do ankles pumps in this position to keep the ba
Knee Extension Series		
Retlouping (**FLEX QUADS**)	2x20 Big head nods	1)Toes up 2) **Max** reach forward 3) Chin to Chest Nods
Belt Stretching into Extension	2x3 reps with 10 second Stretch	Pillow under thigh, use belt to stretch off ball of foot
Quad Set | Quad set to Leg Raise Hold	2x45 seconds	**"3 Ingredients"** | squeeze down into pillow and perform
Blood Flow Restriction Sets| Wrap at 7/10 Tightness| Exercise to 8/10 Fatigue then perform Isometric Hold | 3-4 sets total		
BFR: Crutch Quad Sets (**Black BAND**)	2-3 x 8/10 fatigue then Quad plank HOLD	**45 second quad planks**
BFR: Sitting Knee Extension	2-3 x 8/10 fatigue then Quad Plank HOLD	**45 second quad planks**
BFR: Stomach Hamstring Curl	2xfatigue	
Sidelying Hip Lift HOLD	3x45-60 seconds	¼ turn toward stomach | Feel in "high, back, butt muscle

FITT-VP Prescription

Frequency: 2x/day
Intensity: 60-100% LOP
Type: OKC/CKC/Thera-band Exercises
Time: 15-25 minutes
Volume: 4-6 sets at 3-8 minutes
Progression: External load as tolerated



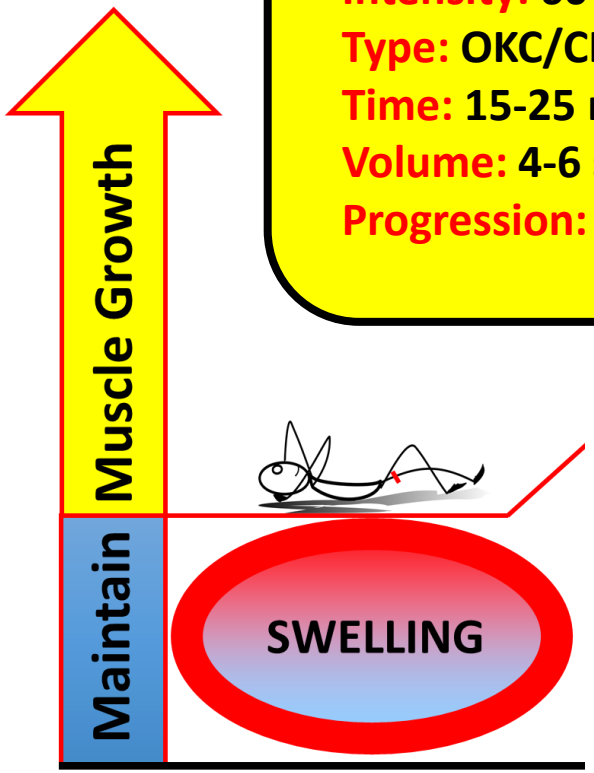
Time of Day	Monday	Tues				ay
6-8AM (Before Class)	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets
3-5PM (After Class)	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets	Knee Extension Blood Flow Restriction Sets

TWIN CITIES ORTHOPEDICS | TRAINING HAUS

Cell Swelling Mechanism

FITT-VP Prescription

Frequency: 2x/day
Intensity: 60-100% LOP
Type: OKC/CKC/Thera-band Exercises
Time: 15-25 minutes
Volume: 4-6 sets at 3-8 minutes
Progression: External load as tolerated



Clinic + Home BFR

healthcare

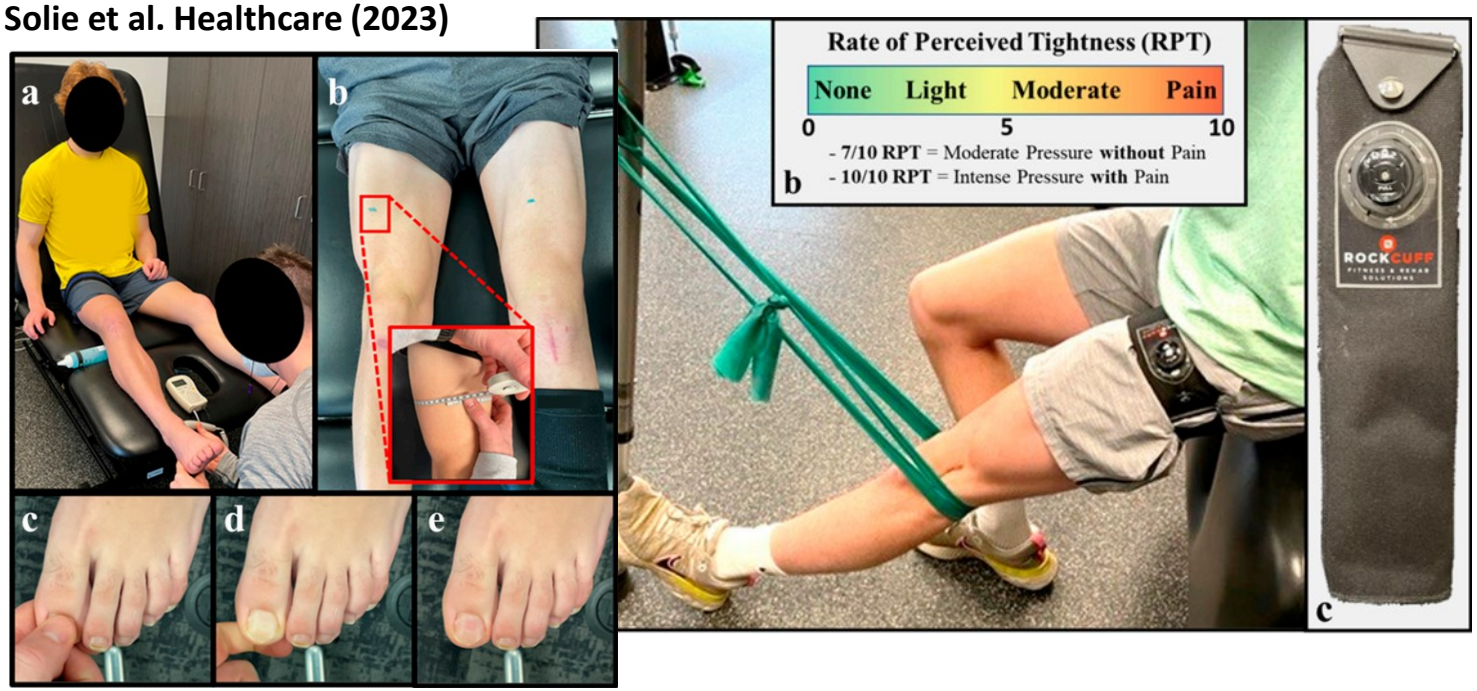
MDPI

Case Report

Clinic and Home-Based Exercise with Blood Flow Restriction Resolves Thigh Muscle Atrophy after Anterior Cruciate Ligament Reconstruction with the Bone-Patellar Tendon-Bone Autograft: A Case Report

Braidy S. Solie [1,*], Garrett G. Eggleston [1], Nicole A. Schwery [1], Christopher P. Doney [1], Michael T. Kiely [1] and Christopher M. Larson [2]

Solie et al. Healthcare (2023)



Journal of Athletic Training 2021;56(9):937–944
doi: 10.4085/418-20

www.natajournals.org

Current Clinical Concepts

Blood Flow Restriction Training

Daniel S. Lorenz, DPT, PT, ATC, CSCS*; Lane Bailey, PhD†; Kevin E. Wilk, DPT, PT‡; Robert E. Mangine, MEd, PT, ATC§; Paul Head, MSc, MCSP, HCPC‖; Terry L. Grindstaff, PhD, PT, ATC, SCS¶; Scot Morrison, DPT#

Journal of Human Kinetics volume 74/2020, 85-97 DOI: 10.2478/hukin-2020-0016 85
Resistance Training in Health and Sports Performance

sciendo

Does Acute Blood Flow Restriction with Pneumatic and Non-Pneumatic Non-Elastic Cuffs Promote Similar Responses in Blood Lactate, Growth Hormone, and Peptide Hormone?

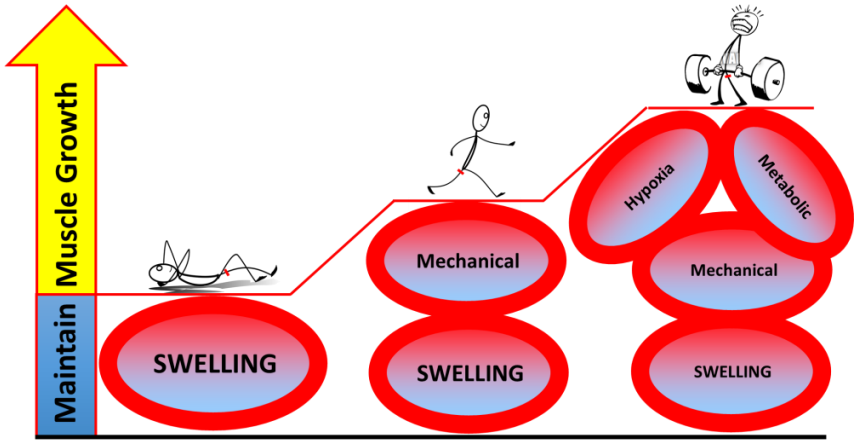
Lorenz et al. *JAT* (2021)

Oliveira, Jorge, et al. JHK (2020)

Mechanical + Hypoxia/Metabolic

FITT-VP Prescription

Frequency: 2-5x/week
Intensity: 60-100% LOP | 15-50 RM
Type: OKC/CKC/Body Weight/Machines
Time: 1-2 minutes/set
Volume: 3-4 sets per muscle group
Progression: External load as tolerated



[redacted]

Activity	Sets/Reps	Exercise Recommendations and Details to Focus On
Blood Flow Restriction Exercises		
BFR: Crutch Quad Sets	2 x 8/10 fatigue then Quad plank HOLD	
BFR: Stomach Hamstring Curl	2x**fatigue**	**TOES UP toward shin THE WHOLE TIME** Hands VERY close to knee when grabbing belt | Bicep curl as you hamstring curl

Dynamic Exercises
Hamstring SuperSet: Alternating Sliders (Butt Down), Hamstring Bridge |**2x30 seconds each**
Glute Series: Wide band waddles (**legs straight**) Side-Side step (**squat positions**), 2-step (**squat position**)| **2x 10 yards each with 30 sec on side-side step**

Blood Flow Restriction Exercises		
BFR: Single Leg press	3xfatigue with 45 second ISO	**2 Bands**
BFR: Wobble board squats	3xfatigue	**GOOD LOCKOUT**
BFR: Single Leg Knee Extension Machine	3xfatigue	**WEIGHT| 10 PSI** **1-6-4-3-2 METRONOME**

Time of Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6-8AM (Before Class)	OPEN PT	OFF	OFF	Blood Flow Restriction Sets	OPEN PT	Blood Flow Restriction Sets
3-5PM (After Class)	Blood Flow Restriction Sets	Physical Therapy	OFF	Physical Therapy	OFF	Blood Flow Restriction Sets

TWIN CITIES ORTHOPEDICS | TRAINING HAUS

Mechanical + Hypoxia/Metabolic

FITT-VP Prescription

Frequency: 2-5x/week
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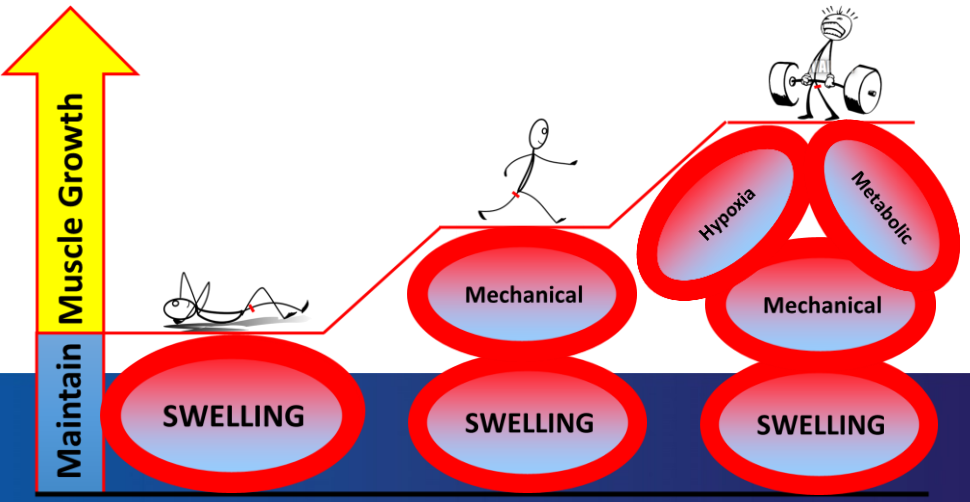


Mechanical + Hypoxia/Metabolic

FITT-VP Prescription

Frequency: 2-3x/week
Intensity: 60-100% LOP | 12-20 RM
Type: OKC/CKC/Body Weight/Machines
Time: <1 minute/set
Volume: 3-4 sets per muscle group
Progression: External load as tolerated

[redacted]. | ACL Surgery |Return to Soccer Rehab Card |

[redacted]

Activity	Sets/Reps	Exercise Recommendations and Details to Focus On

Bik x 10 min

Dynamic Warmup Exercises:

Leg warmup Triset: Alternating Sliders, Hamstring Bridge (**2 out: 1 in sliders**), Mountain climbers| **2x30 seconds each**

BFR: Single leg Press 1xfatigue | 4-5 bands

Glute Series: Wide band waddles (**legs straight**),Side-Side step, 2-step (**squat position**), Repeated Side-stepping | x 20 yards each with 30 sec on side-side step

BFR: Single leg Press 1xfatigue | 4-5 bands

Chop Series: Inside knee, Outside knee, Power rotation **over front leg first** (hands at chest at center position) | **x10 yards each**

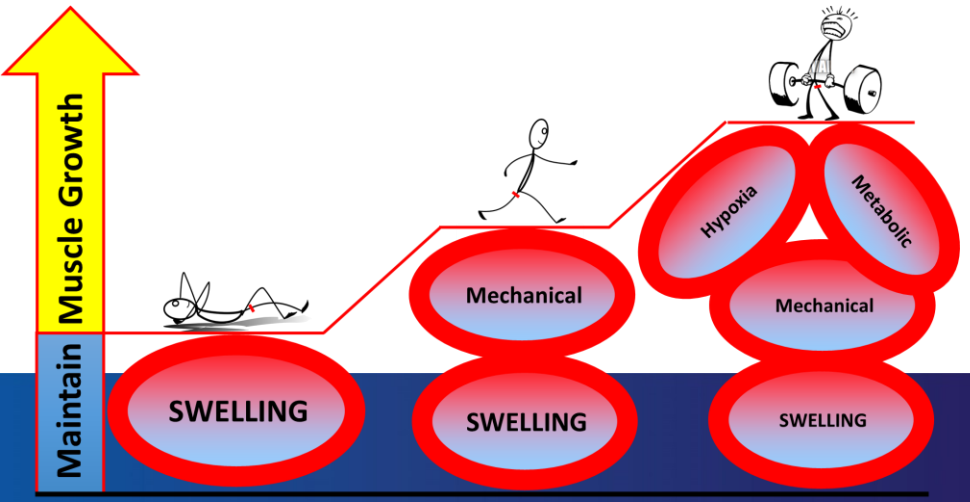
BFR: Single leg Press 1xfatigue | 4-5 bands

Single Leg Series: Single leg squat **x6 each leg**, Puddle Steps **x 20 yards** , Single Leg Squat to lateral step **x6 each way** | **2 rounds**

Plyometric Series 1: Stiff/Stiff, Soft/Soft, Rainbow Hops, Push to base | **x20 yard each**

Running Card

Circuit		
BFR: Single leg Knee Extensions	3xfatigue	20-30 | 1-6-4-2
Suitcase Lunge (30# DB)	3x10 yard each way (Smooth)	
Adductor Holds	3x30 seconds each side	Leg Support: MID CALF?
Wobble Board Double-leg dumbbell Curl to POWER Push	3x10 reps	**WEIGHT| 15# DBs** Focus on Rate of force development



Time of Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
3-5PM (After Class)	SMALL GROUP	Physical Therapy	OFF	OPEN Physical Therapy	SMALL GROUP	HOME Workout 1

TWIN CITIES ORTHOPEDICS | TRAINING HAUS

Mechanical + Hypoxia/Metabolic

FITT-VP Prescription

Frequency: 2-3x/week
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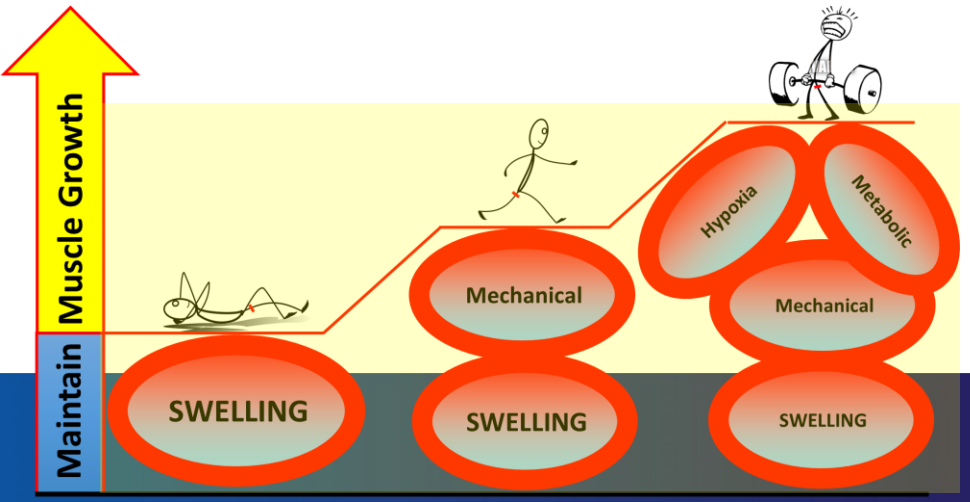
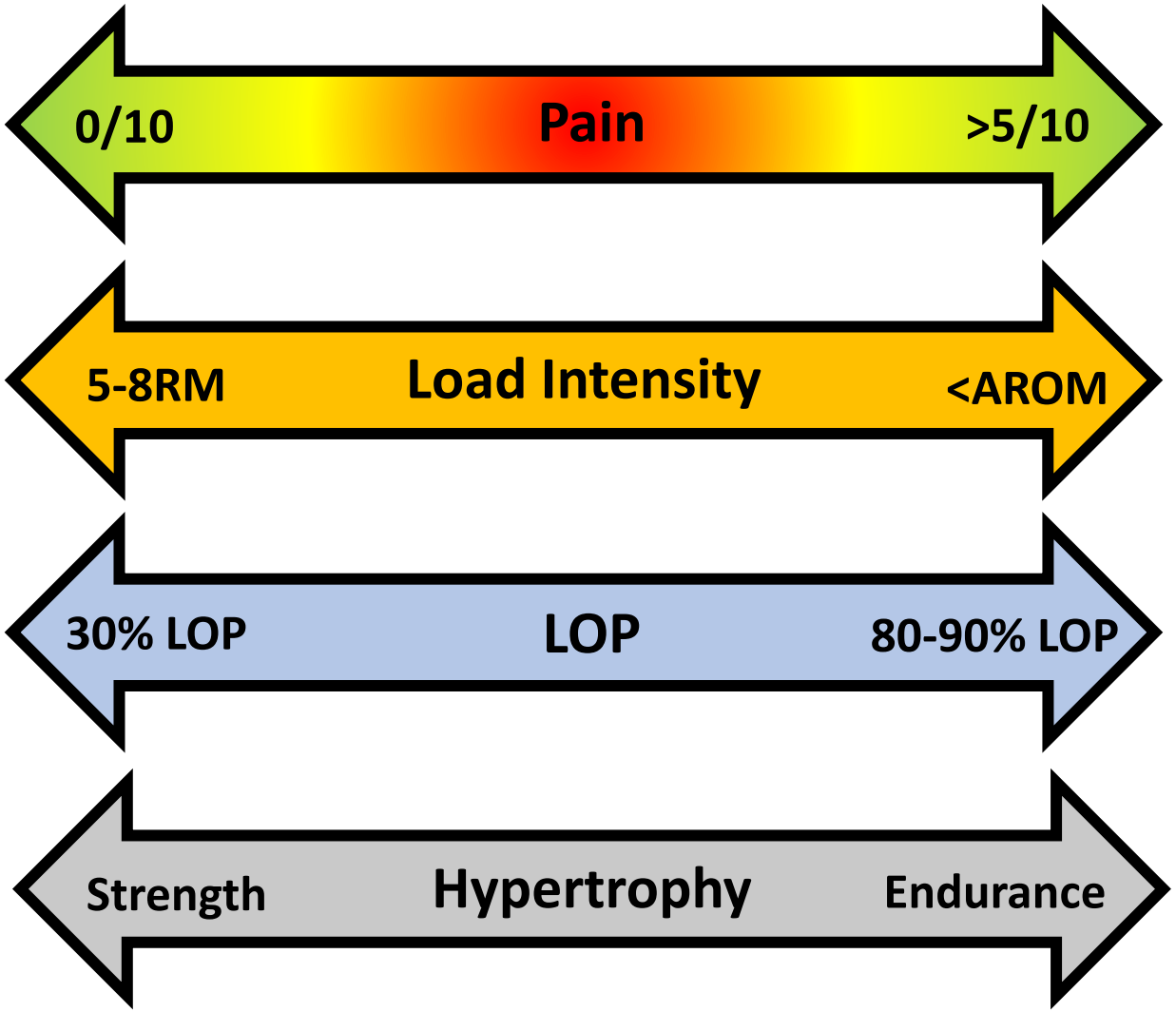
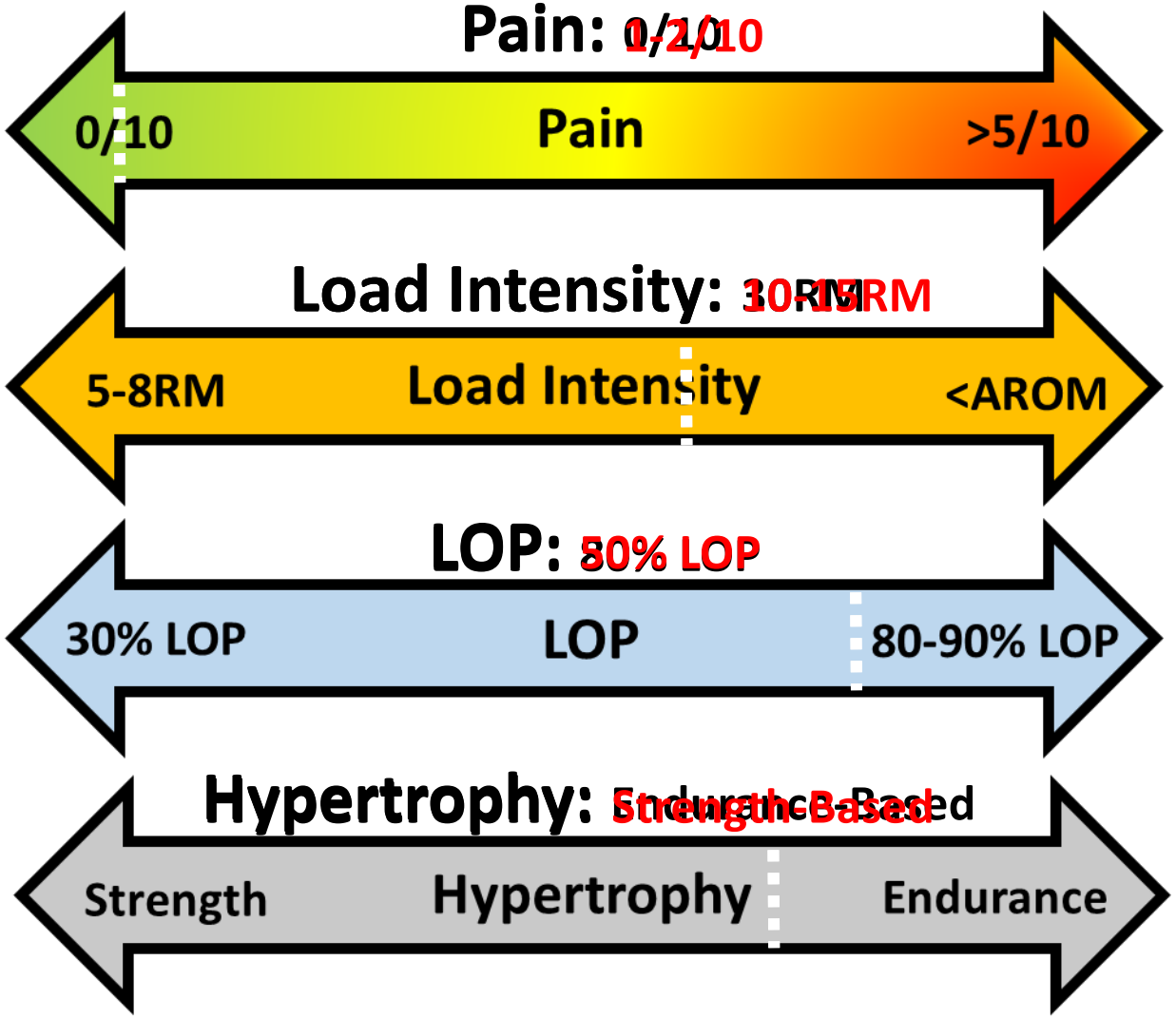


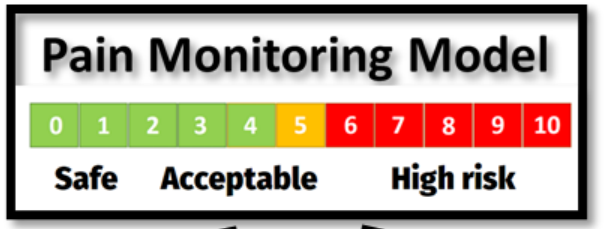
BFR Clinical Continuum



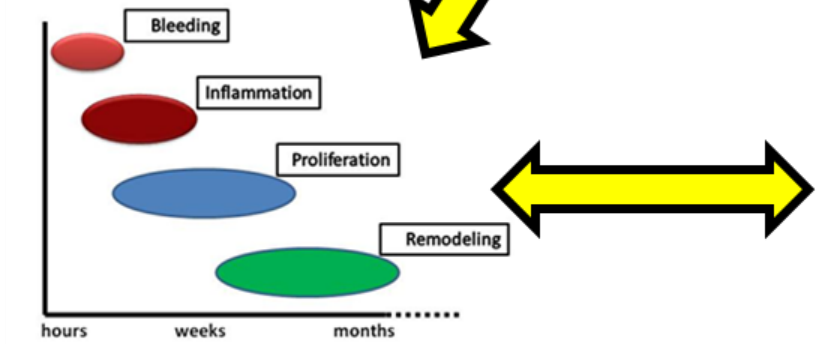
Clinical Continuum Example



Summary



The **BFR Prescription**
must be tailored for
rehabilitation



Stages of Tissue Healing

RPE Scale

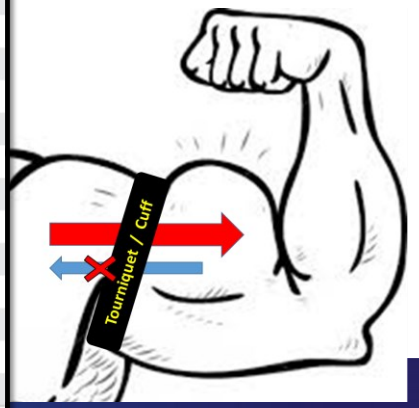
ing	Descriptor
0	Rest
1	Very easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	
7	Very hard
8	
9	
10	Maximal

Summary

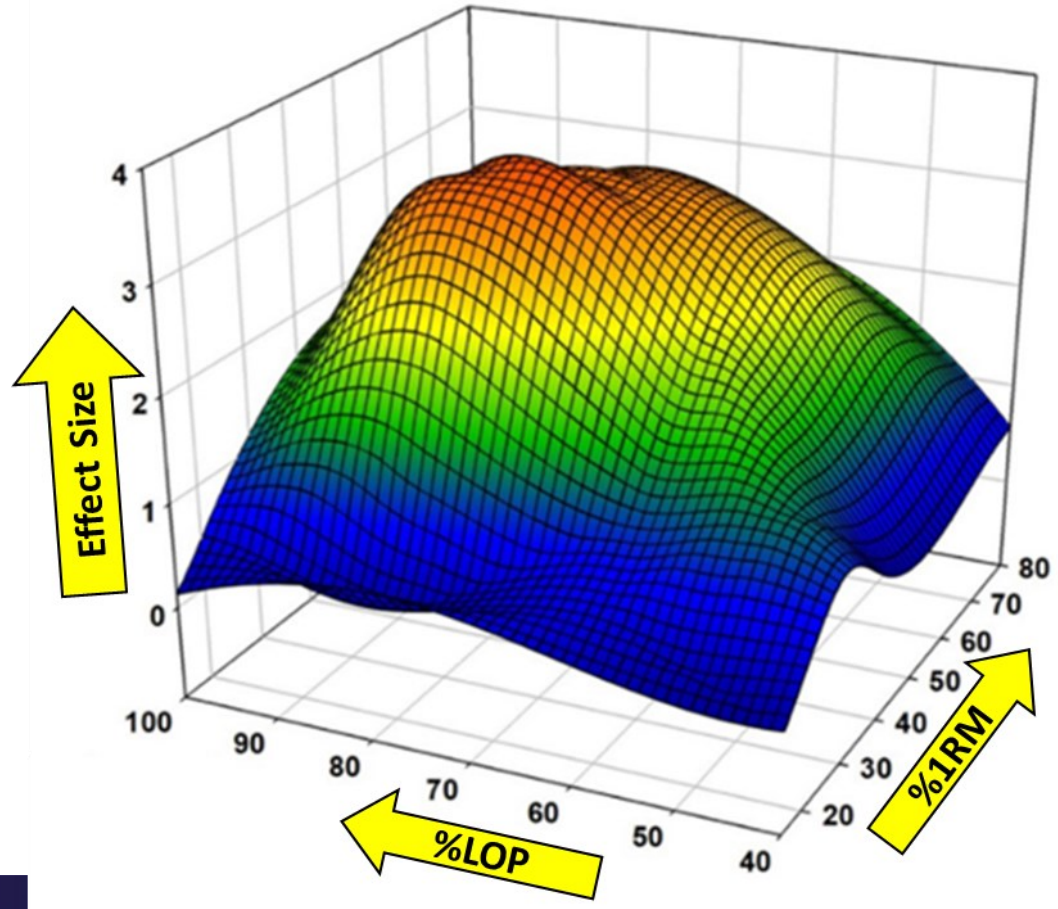
There is a **large** occlusion pressure **therapeutic** window…

52 BFR Studies

Valenzuela et al[30]	Mattocks et al[20]
Reis et al[32]	Kim et al[41]
Petrick et al[33]	Ferreira et al[42]
Montgomery et al[34]	Dankel et al[75]
Ilett et al[17]	Clarkson et al[8]
Hughes et al[66]	Buckner et al[19]
Chulvi-Medrano et al[35]	Poton and Polito[58]
Centner et al[52]	Pinto and Polito[63]
Jessee et al[67]	Neto et al[24]
Kilgas et al[36]	Fatela et al[43]
Dankel et al[68]	Counts et al[44]
Thomas et al[37]	Barnett et al[45]
Stavres et al[53]	Staunton et al[46]
Soligon et al[54]	Poton and Polito[47]
Scott et al[60]	Moriggi Jr et al[25]
Pinto et al[61]	Lixandrão et al[48]
Picón et al[55]	Araújo et al[64]
May et al[38]	Araújo et al[65]
Letieri et al[62]	Santos et al[59]
Ladlow et al[56]	Araújo et al[49]
Jessee et al[69]	Laurentino et al[50]
Jessee et al[39]	Laurentino et al[51]
Jessee et al[70]	
Hughes et al[71]	
Curty et al[57]	
Buckner et al[72]	
Bell et al[73]	
Tennent et al[74]	
Neto et al[40]	
Mouser et al[31]	



Blood Flow Restriction (BFR)
30-100%
Limb Occlusion Pressure



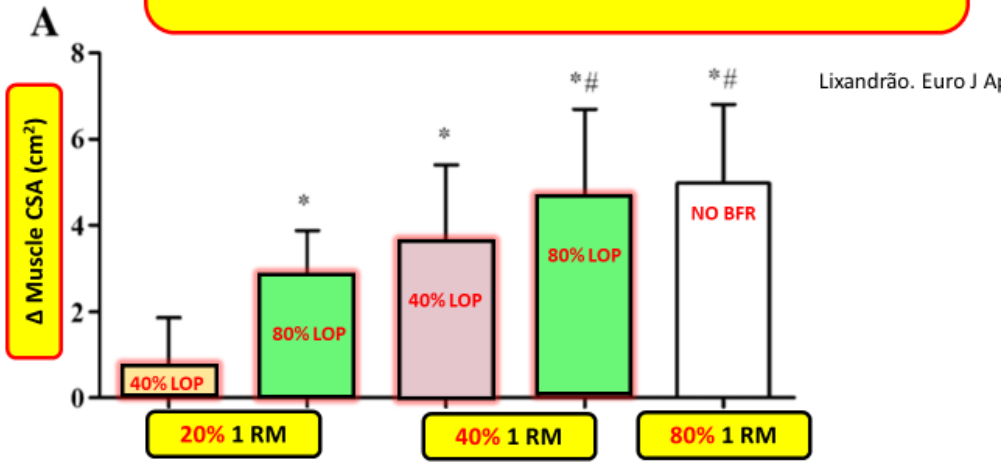
TWIN CITIES ORTHOPEDICS | TRAINING HAUS

Summary

Rehabilitation exercises that are **low load**

will benefit from **Higher** **Occlusion Pressures**..

Higher occlusion pressures are beneficial with **low intensity exercise**.



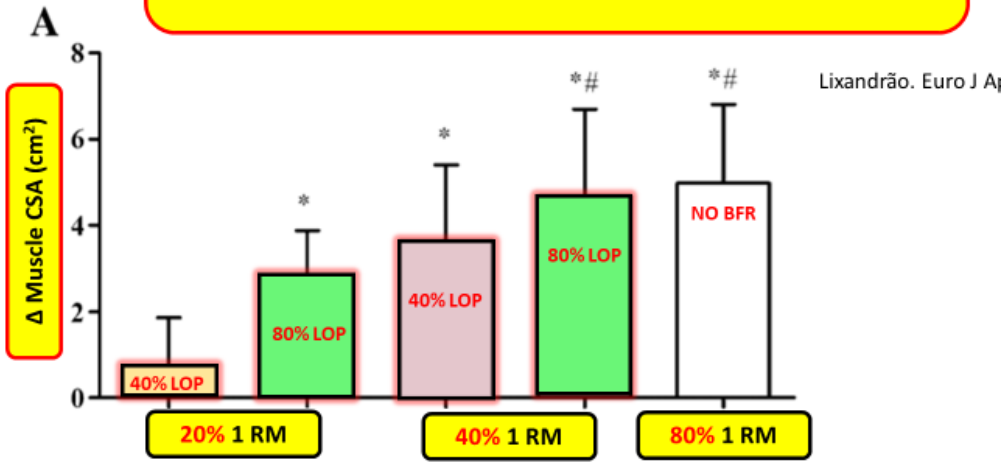
Lixandrão. Euro J A

Summary

Rehabilitation exercises that are **low load**

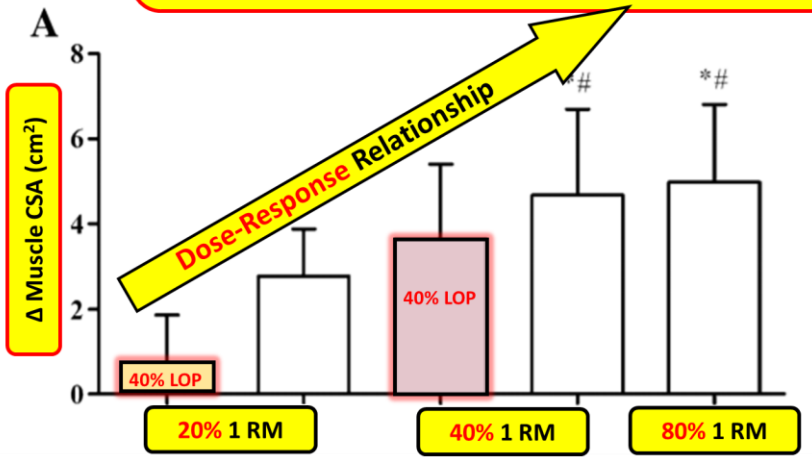
will benefit from **Higher** **Occlusion Pressures**..

Higher occlusion pressures are beneficial with **low intensity exercise**.



Lixandrão. Euro J A

Low Pressures will still produce some beneficial adaptation.

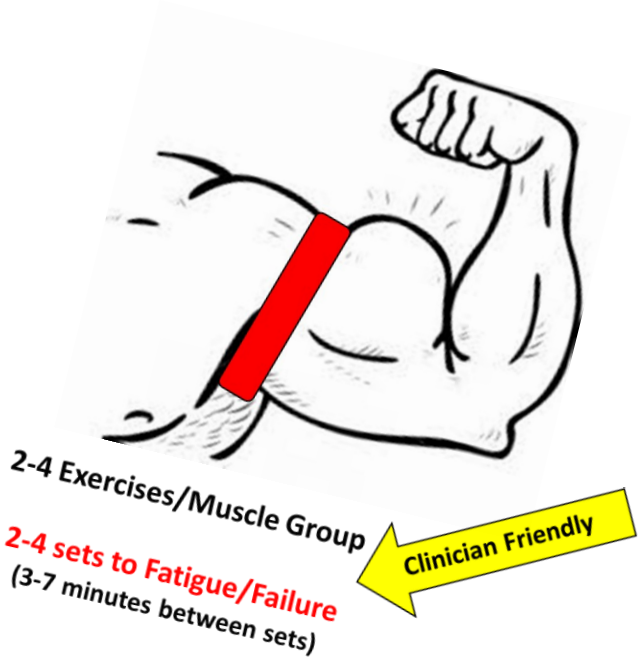


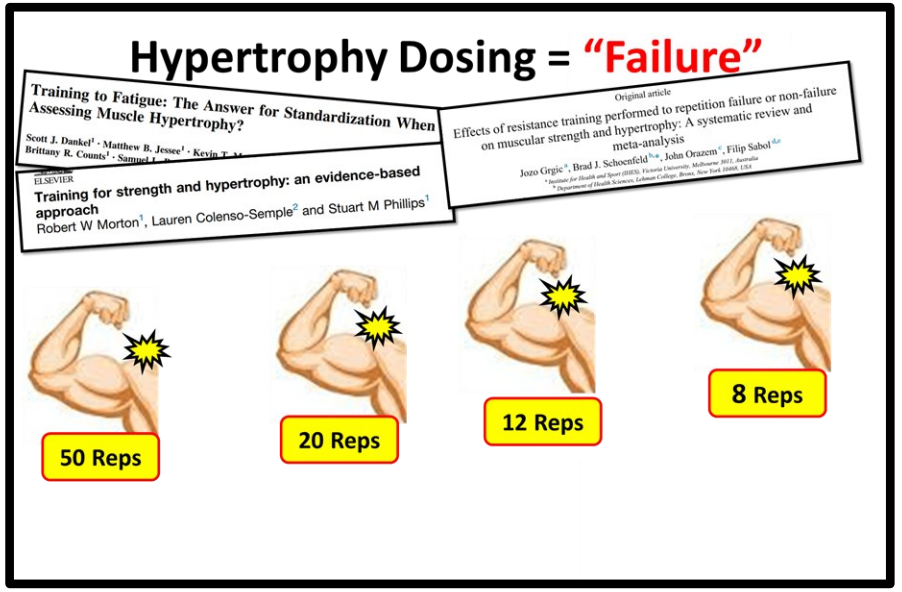
..but **Under-Occluding** will still give you something…

Summary

Sets to Failure may be a more clinic friendly way of

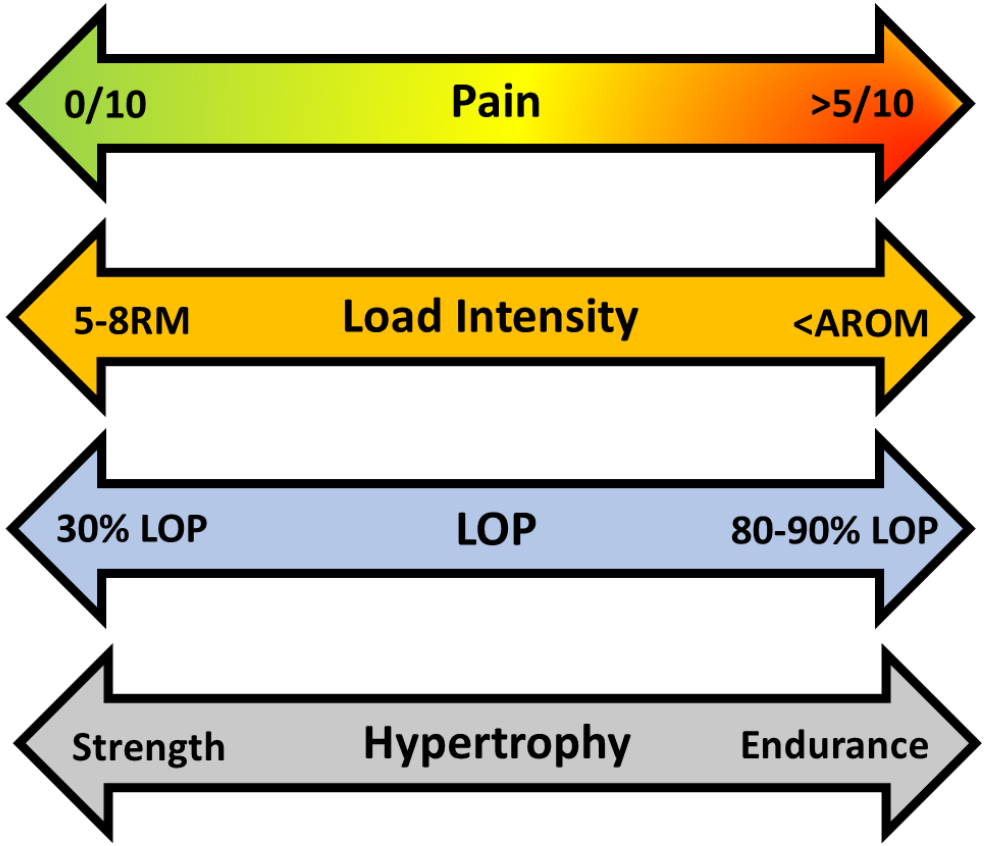
Dosing BFR…





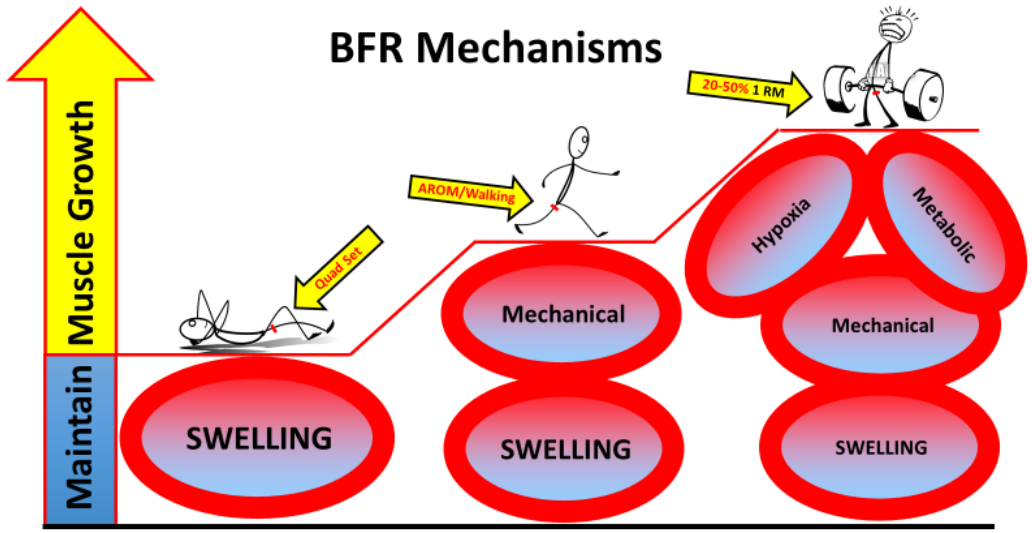
Summary

Understand how to manipulate **Pain, Load, and Occlusion Pressure** within the BFR Exercise Prescription...



Summary

Organization and consistency is key!..



FITT-VP Prescription

Frequency: 2-3x/week
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Time: <1 minute/set
Volume: 3-4 sets per muscle group
Progression: External load as tolerated

Bik x 10 min

Sets/Reps	Exercise Recommendations and Details to Focus On

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Leg warmup Triset: Alternating Sliders, Hamstring Bridge (**2 out: 1 in sliders**), Mountain climbers| **2x30 seconds each**
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Chop Series: Inside knee, Outside knee, Power rotation **over front leg first** (hands at chest at center position) | **x10 yards each**
BFR: Single leg Press 1xfatigue | 4-5 bands
Single Leg Series: Single leg squat **x6 each leg**, Puddle Steps **x 20 yards** , Single Leg Squat to lateral step **x6 each way** | **2 rounds**
Plyometric Series 1: Stiff/Stiff, Soft/Soft, Rainbow Hops, Push to base | **x20 yard each**

Running Card

Circuit

Knee Extensions	3xfatigue	20-30 | 1-6-4-2
[illegible] yard each way (Smooth)		Leg Support: MID CALF?

Time of Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
3-5PM (After Class)	SMALL GROUP	Physical Therapy	OFF	OPEN Physical Therapy	SMALL GROUP	HOME Workout 1

Thank You!

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2645 Vikings Circle, Suite 200 | Eagan, MN 55121
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E: Braidysolie@TrainingHAUS.com | TrainingHAUS.com

Part 2: BFR Learning Lab

Group 1: Chee Vang, DPT

-Upper Body BFR

-Hip and Ankle BFR

Group 2: Braidy Solie, DPT

-Quad and Hamstring BFR

-Practical/Home BFR Setup

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