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PARKER

Blood Flow Restriction & Spinal Cord Injury (SCI)

Safely Maintain & Build Muscle Mass TO IMPROVE Function

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Notes & References:
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OBJECTIVE

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OBJECTIVE

INTRODUCE THE SAFETY AND EFFICACY OF USING BFR WITH SCI PATIENTS TO HELP IMPROVE MUSCLE MASS, STRENGTH AND AERobic CAPACITY

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INTRODUCTION

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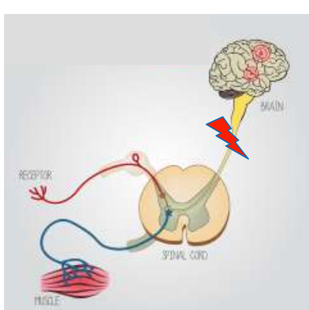
Spinal Cord Injury (SCI)

"Neurological Disorders that temporarily or permanently disrupt the propagation of action potentials along the spinal cord, resulting in motor dysfunction, paralysis, autonomic disorders, and other symptoms that impact daily activities and quality of life"



Kawanishi CY, Greguol M. Physical activity, quality of life, and functional autonomy of adults with spinal cord injuries. Adapt Phys Activ Q 2013;30:317-337

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INCOMPLETE SPINAL CORD INJURIES (iSCIs)

1. National Spinal Cord Injury Statistical Center. Spinal Cord Injury (SCI) Facts and Figures at a Glance. 2016 SCI Data Sheet.
2. Roberts TT, Leonard GR, Cepela DJ. Classifications In Brief: American Spinal Injury Association (ASIA) Impairment Scale. Clin Orthop Relat Res 2017;475:1499-1504.

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INCOMPLETE SPINAL CORD INJURIES (iSCIs)

- Approximately 67% of all SCI's since 2010[1]
- Characterized by residual sensory or motor function at or above the most caudal regions of spinal cord[2]
- Lower Limb Function varies widely
- MUSCLE ATROPHY!

1. National Spinal Cord Injury Statistical Center. Spinal Cord Injury (SCI) Facts and Figures at a Glance. 2016 SCI Data Sheet.
2. Roberts TT, Leonard GR, Cepela DJ. Classifications In Brief: American Spinal Injury Association (ASIA) Impairment Scale. Clin Orthop Relat Res 2017;475:1499-1504.

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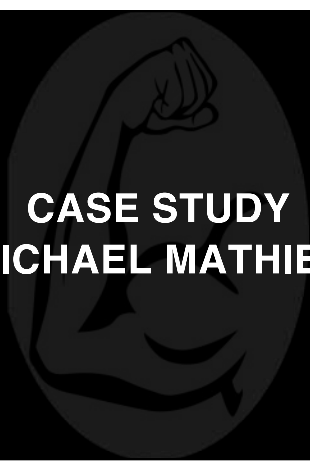

CASE STUDY MICHAEL MATHIEU

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DISUSE ATROPHY POST INJURY CAN BE SIGNIFICANT!!

↓ MPS 27-31% + ↓ STRENGTH 30%

ANABOLIC RESISTANCE

Significant atrophy of type II fibers after only 5 days (!!) of detraining after a 90-day resistance protocol

Jespersen JG, Nedergaard A, Andersen LL, Schjerling P & Andersen JL (2011). Myostatin expression during human muscle hypertrophy and subsequent atrophy: increased myostatin with detraining. Scand J Med Sci Sports 21,215–223.

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IMPORTANCE OF MUSCLE

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MUSCLE ANATOMY & FUNCTION

MUSCLE IMPORTANCE

Physical – Generates force and power; Drives movement; Enables function/activity

Metabolic – Primary site of insulin mediated glucose disposal; Largest reservoir of glycogen

Resilience – Strength, mobility and endurance to reduce frailty

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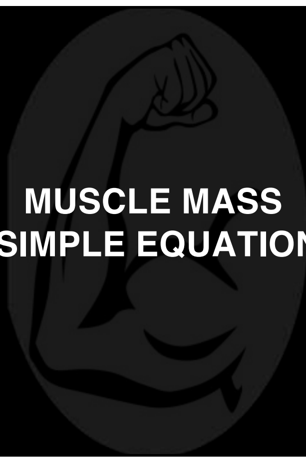

MUSCLE MASS SIMPLE EQUATION

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MUST MAINTAIN POSITIVE PROTEIN BALANCE

MPS – Muscle Protein Synthesis (Muscular Stress + AA's)
MPB – Muscle Protein Breakdown
NPB – Net Protein Balance

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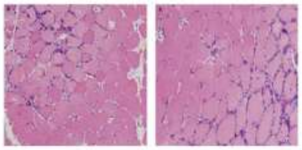
MUSCLE PROTEIN BREAKDOWN (MPB)



- Constant state of protein turnover
- important metabolic component of muscle remodeling
- adaptation to training
- Higher in fasted state

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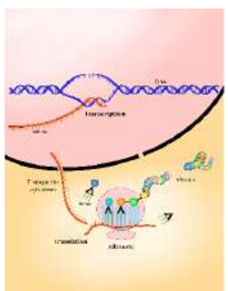
MUSCLE PROTEIN SYNTHESIS

- About 1.2% turnover per day
- After eating increases
- During resistance training, MPS suppressed
- Proteolysis (protein → AA's)



Schoenfeld, B. J. (2013a). Is there a minimum intensity threshold for resistance training-induced hypertrophic adaptations? *Sports Med, 43*(12), 1279-1288. doi:10.1007/s40279-013-0088-z

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MUSCLE PROTEIN SYNTHESIS

- After workout, MPS x 3-5x for 48 hours
- Enhanced translational efficiency
- Repeated bouts over time with sufficient recovery and AA's results in ++NPB
- Hormones play a role in increasing or decreasing translational initiation

Schoenfeld, B. J. (2010). The mechanisms of muscle hypertrophy and their application to resistance training. *Journal of strength and conditioning research, 24*(10), 2857-2872.

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ADEQUATE MUSCULAR STRESS
+
ADEQUATE AMINO's

= Positive Protein Balance

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What IS TYPICAL adequate Muscular Stress?

Muscles must be subjected to substantially increased load

ACSM Recommends: HIT (> 70% 1RM)

Meyer, R. A. (2006). Does blood flow restriction enhance hypertrophic signaling in skeletal muscle? J Appl Physiol (1985), 100(5), 1443-1444.

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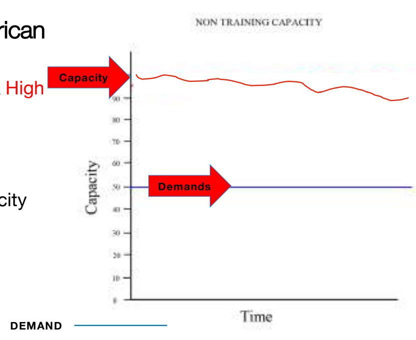
Typical American

- Not Training At A High Enough Intensity
- Low Demands
- Decreased Capacity over time
- Sarcopenia



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INCOMPLETE SPINAL CORD INJURIES (iSCIs)

PROBLEMS

- Injury related motor impairment
- Limits exercise intensity

SOLUTION

- Exercise Program promoting maximal muscular adaptations to light-intensity exercise

Kozlowski AJ, Heinemann AW. Using individual growth curve models to predict recovery and activities of daily living after spinal cord injury: An SCIRehab project study. Arch Phys Med Rehabil 2013;94(4 suppl):S154-164 e151-154

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BFR TRAINING AS A SOLUTION

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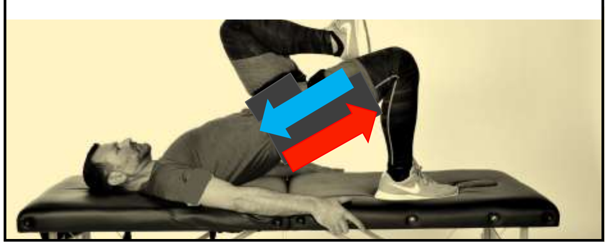
NORMAL EXERCISE BLOOD FLOW



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WHAT IS BLOOD FLOW RESTRICTION TRAINING?

BFR is the brief and intermittent occlusion of arterial and venous blood flow using a tourniquet while at rest or exercising. Using this technique, you can exercise using significantly less weight and still achieve significant gains in muscle strength and size.

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"IMPORTANTLY, RESEARCH SUGGESTS THAT LOW LOAD RESISTANCE EXERCISE (20–30% 1 RM) AND LOW LOAD AEROBIC EXERCISE (<70 M/MIN WALK TRAINING), WHICH WOULD NOT BE EXPECTED TO CAUSE CONSIDERABLE INCREASES IN MUSCULAR QUANTITY OR QUALITY UNDER NORMAL CIRCUMSTANCES, WHEN COMBINED WITH PBFRT PRODUCED AN EXAGGERATED RESPONSE FOR MAXIMIZING MUSCLE STRENGTH AND HYPERTROPHY." (SLYSZ ET AL. 2016)

+ OVER 820+ PUBLISHED ARTICLES IN THE LAST 10 YEARS!

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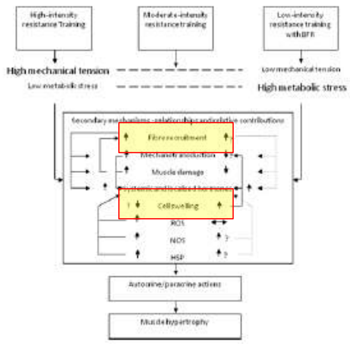
MECHANICAL TENSION & METABOLIC STRESS

Fig. From Pearson & Hussain 2015



Pearson S. J., Hussain S. R. (2015). A review on the mechanisms of blood-flow restriction resistance training-induced muscle hypertrophy. Sports Med. 45 187–200. 10.1007/s40279-014-0264-9

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MUSCLE ANATOMY & FUNCTION

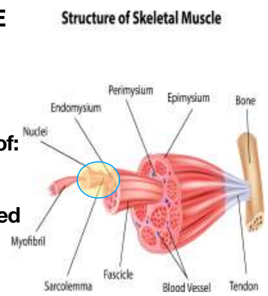
ANATOMY OF A MUSCLE

Muscle is composed of:
- **Bundles of muscle fascicles**

Muscle Fascicles are composed of:
- **Bundles of muscle fibers**

Muscle Fibers (cells) are composed of:
- **Bundles of myofibrils**

Myofibrils are composed of:
- **Bundles of sarcomeres**



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MUSCLE FIBER TYPES

MARATHONER

Type I Fibres
Red in color
Lots of Mitochondria
Used for low force/low power/high endurance

SPRINTERS

Type II Fibres
Fast Twitch
Type IIa & IIb
Used for high force, high power, speed

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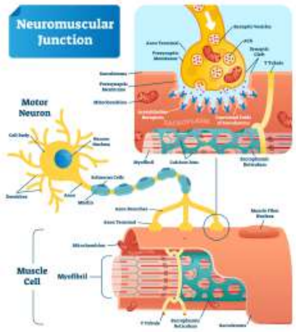
MOTOR UNIT

Motor nerve connects the central nervous system to the muscles

Motor Unit = a motor neuron and all the muscle fibers that motor neuron innervates



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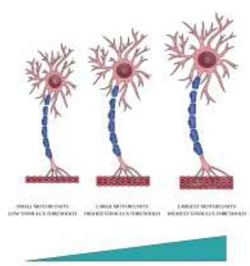
MOTOR UNIT CLASSIFICATION

Low or high threshold

Small Motor Unit = Low Stimulus threshold

Large Motor Unit = Higher stimulus threshold

Largest motor units = Highest stimulus threshold



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The Henneman Size Principal

- Muscle Fiber recruitment follows the size principal
- Smaller, slower units recruited early
- Progressively larger, higher-threshold motor units as force demands increase

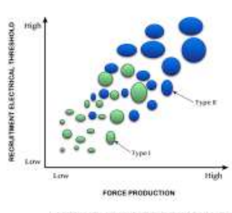

Image Adopted from Schoenfeld, Brad, Science and Development of Muscle Hypertrophy 2018

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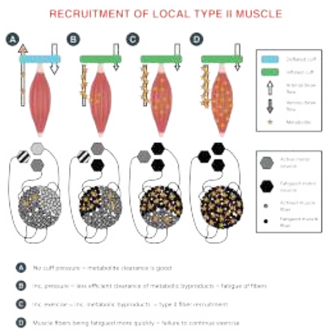
Muscle Fiber Recruitment

- Limit O2 to working muscle
- Switch from aerobic to anaerobic metabolism
- Exercise Acidosis is created faster (metabolites)
- FATIGUE FASTER
- Size Principal



Jessee MB, et al. (2018) Mechanisms of Blood Flow Restriction Training: The New Testament.Techortho. 00.00.1-8

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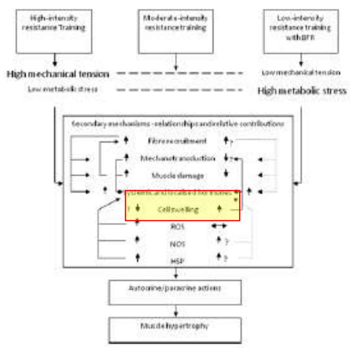
MECHANICAL TENSION & METABOLIC STRESS

Fig. From Pearson & Hussain 2015



Pearson S. J., Hussain S. R. (2015). A review on the mechanisms of blood-flow restriction resistance training-induced muscle hypertrophy. Sports Med. 45 187–200. 10.1007/s40279-014-0264-9

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Cellular Swelling

Similar to a water balloon that continues to fill with water and is at risk of bursting, cells may behave the same way to reinforce their structure to avoid apoptosis (cell death)

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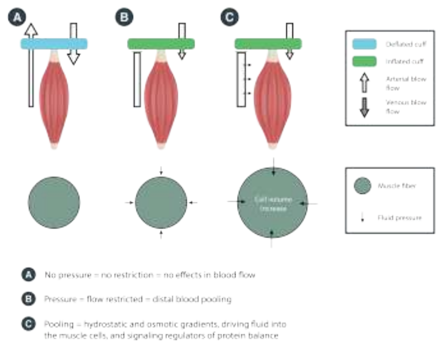
LOCAL MUSCLE CELL SWELLING AND METABOLITES



Jessee MB, et al. (2018) Mechanisms of Blood Flow Restriction Training: The New Testament.Techortho. 00.00.1-8.

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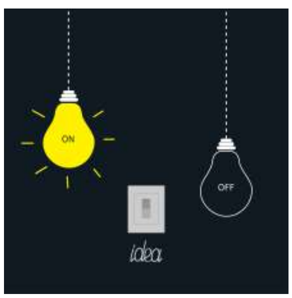
Mammalian Target of Rapamycin Complex (mTORC1)

Signaling Pathway responsible for protein synthesis

Serves as a switch to turn cell growth on or off



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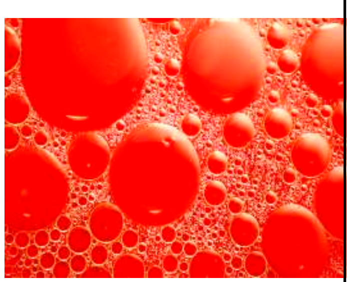
Cellular Swelling

Cell swelling has been shown to increase protein synthesis and suppress proteolysis.(Haussinger 1993, 1996)

Schliess et al.(2006) further linked cellular hydration to mTORC1.



1. Haussinger D, Roth E, Lang F, Gerok W. Cellular hydration state: an important determinant of protein catabolism in health and disease. Lancet (1993); 341: 1330–1332.

2. Haussinger D. The role of cellular hydration in the regulation of cell function. Biochem J 1996;313(Pt3):697–710

3. Schliess, F., Richter, L.,vom Dahl, S., & Haussinger, D. (2006). Cell hydration and mTOR-dependent signalling. Acta Physiol (Oxf), 187(1-2), 223-229

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BFR PROTOCOLS

CELLULAR SWELLING WITH NEMS

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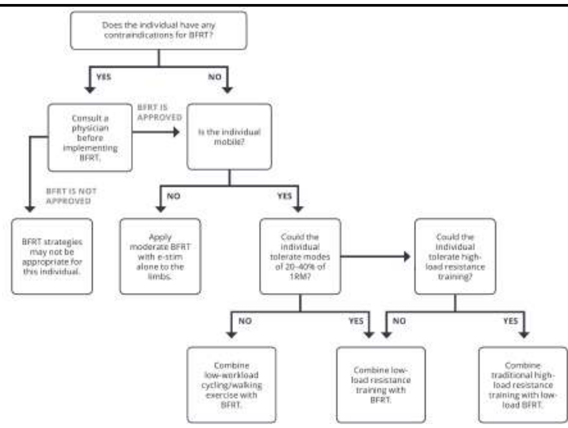

Adopted from Loenneke, J 2015

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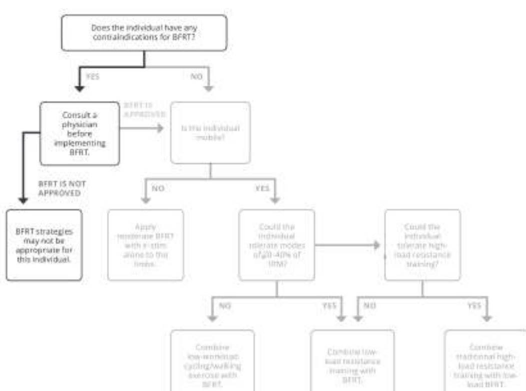

Adopted from Loenneke, J 2015

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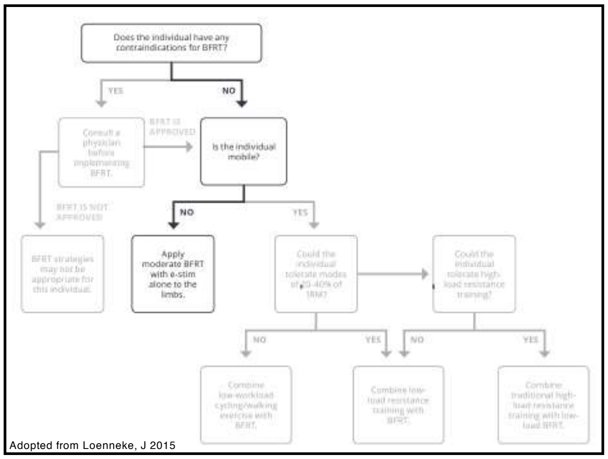

Adopted from Loenneke, J 2015

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MICHAEL'S EXERCISE ROUTINE

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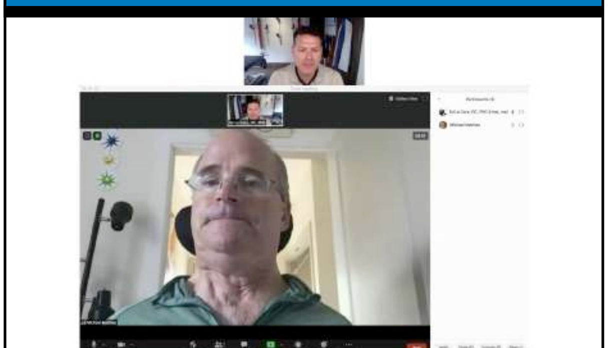

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PROTOCOL #1

Cellular Swelling Protocol with NEMS

5 Minutes on at 80% LOP LE
3 Minutes Rest
X 5 Cycles

Goal: Maintain & Build Muscle Mass

****Can be upper or lower body**

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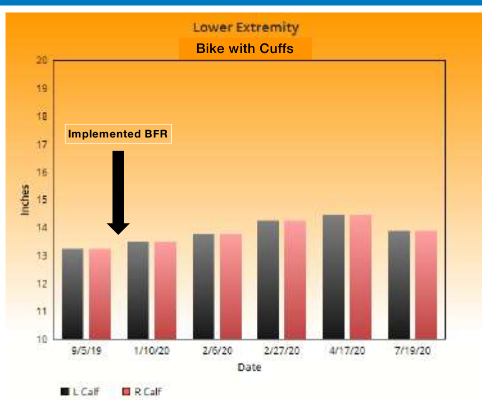

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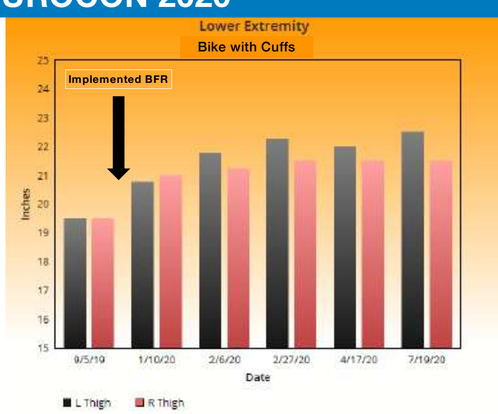

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PROTOCOL #2

Aerobic Capacity Training

5-20 Minutes on at 60% LOP LE

Goal: **Improve Aerobic Capacity**
Strength/size

Use Heart Rate as Guide

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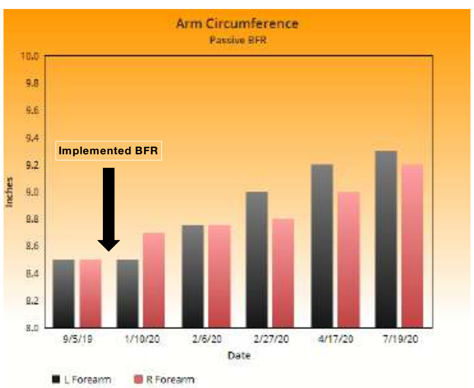

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AM WORKOUT

Stretching with BFR Cuffs on UE

Cellular Swelling Protocol

5 minutes on
3 minutes free flow

5 rounds

PM WORKOUT

Cycle

15-20 minutes

30% - 45% Heart Rate Reserve

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CURRENT EVIDENCE
BFR & SCI

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RESEARCHER CONCLUSIONS

- BFR exercise can be performed safely and tolerated well
- No additional cardiovascular strain compared with traditional resistance exercise
- Increases in local blood volume and osmotic pressure gradients favoring cell swelling


Original Research
The Feasibility of Blood Flow Restriction Exercise in Patients With Incomplete Spinal Cord Injury
Jon Stavres, PhD, Tyler J. Singer, MS, Amber Brochetti, DPT, Martin Kilbane, PT, DPT, OCS, Steven Brose, DO, John McDaniel, PhD

Stavres, J., Singer, T. J., Brochetti, A., Kilbane, M. J., Brose, S. W., & McDaniel, J. (2018). The Feasibility of Blood Flow Restriction Exercise in Patients With Incomplete Spinal Cord Injury. *PM & R : the journal of injury, function, and rehabilitation*, *10*(12), 1368–1379. https://doi.org/10.1016/j.pmrj.2018.05.013.

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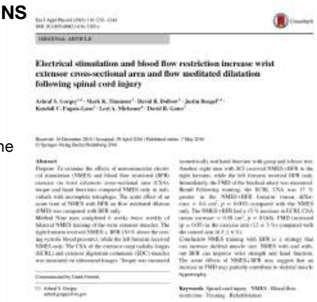
RESEARCHER CONCLUSIONS

- Six weeks of NMES + BFR resulted in a meaningful muscle hypertrophy
- Notable improvement in the electrically evoked strength of the wrist extensor muscles
- Clinical improvement in hand function as determined by decrease in the time and the increase speed of moving the selected objects



Electrical stimulation and blood flow restriction increase wrist extensor cross-sectional area and flow meditated dilatation following spinal cord injury

Gorgey, A. S., Timmons, M. K., Dolbow, D. R., Bengel, J., Fugate-Laus, K. C., Michener, L. A., & Gater, D. R. (2016). Electrical stimulation and blood flow restriction increase wrist extensor cross-sectional area and flow meditated dilatation following spinal cord injury. *European journal of applied physiology*, *116*(6), 1231–1244. https://doi.org/10.1007/s00421-016-3385-z

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SUMMARY

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SUMMARY

- Exercise is vital for health and maintaining muscle mass
- Blood Flow Restriction Training is a safe and effective option for many types of individuals
- BFR is Easy to implement (but not simple)

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WANT TO LEARN MORE?

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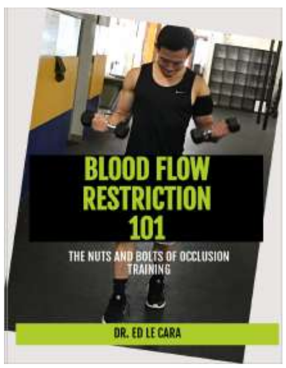
PowerPoint Notes & Learn More About BFR

www.edlecara.com/neurocon2020
Free 2 Hour Training

Resources for tools and learning



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THANK YOU!!

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Former Director of Education, RockTape
Former VP Sports Science, 24 Hour Fitness

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