

## Blood Flow Restriction for Post Operative Therapy

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## Disclosure/COI

- No disclosures or conflicts of interest relevant to the presentation
- The opinions expressed in this presentation are the author's own and do not reflect the view of the United States government



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## Blood Flow Restriction

- Amputees "high energy return" prosthesis
- IDEO™: Intrepid Dynamic Exoskeletal Orthosis
- Idea for BFR was born out of quadricep strength deficit in injured soldiers







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## SAMMC

### Blood Flow Restriction

- Use of a tourniquet during PT for strength gain and muscle hypertrophy without needing to lift heavy weights (80% 1RM)
- Apply tourniquet at **80% of systolic pressure**
- Use **30%** of 1 rep maximum (use contralateral extremity to determine)
- 4 sets of 30/15/15/15 repetitions
- Tourniquet up the entire time and let down after the 4<sup>th</sup> set


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## SAMMC

### Blood Flow Restriction

The efficacy of blood flow restricted exercise: A systematic review & meta-analysis

Joshua Slys, Jack Shultz, James F. Ruge   
Human Performance and Health Research Laboratory, University of Guelph, Canada  
J.Sci.Med.Sport, 2015 Sep 28; pii: S1440-2440(15)00182-6; doi: 10.1016/j.jsams.2015.09.005. [Epub ahead of print]

- Compared to work matched controls BFR demonstrated significantly higher levels of **strength gain** and **muscle hypertrophy** with low load exercise (20% 1 RM)




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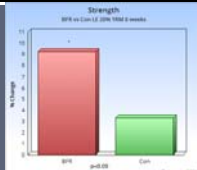
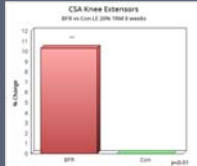
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## SAMMC

### Blood Flow Restriction Does it Work

- Strength gain** compared to work match controls
- Cross sectional Area** compared to controls


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## Blood Flow Restriction

- BFR use during walking improves

### VO<sub>2</sub> max

BFR Walk vs Con (Elite Athletes)

Group	Improvement (%)
BFR	11.8%
Con	0%

park 2010

### Elderly strength

BFR Walk vs Con (Elderly 50 wk 8 min)

Group	% Change
BFR	~14%
Con	~2%

Nov 2011

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## Blood Flow Restriction

- Cycling study of healthy volunteers
- BFR 15 min at low intensity vs 45 min control
- BFR had much greater strength gain and quad hypertrophy with less time of work

40% VO<sub>2</sub> 3x wk 8 wks  
Abe et al 2010

### Thigh and Quad CSA

BFR Cycle 15 min vs Con Cycle 45 min (40% VO<sub>2</sub> 3x wk 8 wks)

Group	Thigh CSA Change (%)	Quad CSA Change (%)
BFR	~10%	~12%
Con	~2%	~3%

Nov 2010

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## Blood Flow Restriction

### Just for leg strength?

- The effects are not just "down stream" from the tourniquet
- Gluteus and pectoralis/triceps strength gain and hypertrophy

### CSA

BFR vs Control (40% VO<sub>2</sub> 3x wk 8 wks)

Group	Thigh CSA (%)	Quad CSA (%)	Triceps CSA (%)
BFR	~10%	~12%	~5%
Con	~2%	~3%	~1%

Nov 2010

### CSA Pec/Triceps

BFR vs Control (40% VO<sub>2</sub> 3x wk 8 wks)

Group	Pec CSA (%)	Triceps CSA (%)
BFR	~10%	~5%
Con	~2%	~1%

Nov 2010

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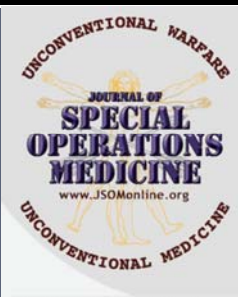
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## Blood Flow Restriction SAMMC

- Prior studies on healthy volunteers
  - Benefits even compared to intense/heavy exercise
- First study on postop patients - special operation units
- Combat injuries with severe quad atrophy



UNCONVENTIONAL WARFARE  
JOURNAL OF SPECIAL OPERATIONS MEDICINE  
www.JSOMonline.org  
UNCONVENTIONAL MEDICINE

Hyblin, C., Burns, T., Owens, J., "Blood Flow Restriction Rehabilitation for Extremity Weakness: A Case Series," Journal of special operations medicine: a peer reviewed journal for SOF medical professionals 15.1 (2014): 50-56.

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## Blood Flow Restriction SAMMC

**Blood flow restriction rehabilitation for extremity weakness: a case series.**  
Hyblin, C., Burns, T., Stone, D., Owens, J.  
 J. Spec. Oper. Med., 2015 Spring 15(1):50-6.

After 2 weeks of training all patients demonstrated improvement in high strength with average power improving 42% to 81% respectively.



**Mean Improvement after Two Weeks (6 Sessions) of BFR Training**

Legend: ■ Peak Torque ■ Average Power ■ Total Work

X-axis: Extension Speed 1, Flexion Speed 1, Extension Speed 2, Flexion Speed 2

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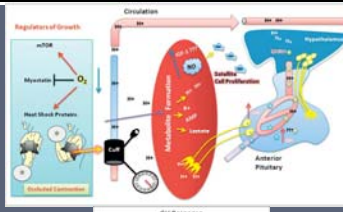
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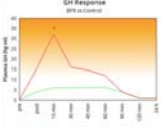
## Blood Flow Restriction SAMMC

### Anaerobic and Cell Swelling

- Muscle switches from aerobic to **anaerobic** metabolism
- Lactate and acidic environment stimulates pituitary to **produce GH and IGF1**
- Cell signaling to increase **protein synthesis**, satellite cells become **myocytes**, cellular swelling, and muscle hypertrophy



**Regulation of Growth**



**GH Response (BFR vs Control)**

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### Blood Flow Restriction Anaerobic and Cell Swelling

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- Decreased atrophy when BFR is used without exercise
  - Isometrics immediately postop
  - ICU patients?
  - Neuro rehab?


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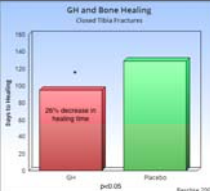
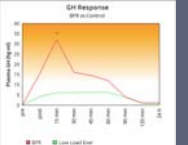

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### Blood Flow Restriction Fracture Healing

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- Promote fracture healing?
- PRCT
- Exogenous administration of GH reduced healing time in closed tibia fractures


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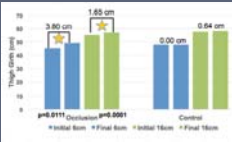

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### Blood Flow Restriction Ongoing Research

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- Current studies:**
  - Completed the knee arthroscopy pilot
  - ACL/Chronic Thigh Weakness (AMMTI \$215,000)
  - Femur Fractures (CDMRP/PRORP \$4 mill)
  - Distal radius fractures (unfunded)
- Future studies:**
  - TKA
  - Achilles Repairs
  - RC Repairs (fatty infiltration/atrophy/strength)


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### BFR in the Media

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- ESPN SportsCenter
- Sports Illustrated
- Forbes
- 20+ professional sports teams

<https://www.youtube.com/watch?v=eiGpDXWhFA>



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### BFR Risks

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- Only muscle soreness
- No cardiac, vascular, clotting complications have been shown in any study
- We did duplex US on all knee arthroscopy patients without evidence of DVT
- DVTs evaluated in multiple prior studies without evidence of increased risk
  - Some evidence that risk is lower



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### BFR Tourniquet

SAMMC

- Tourniquets are medical devices regulated by FDA
- 3<sup>rd</sup> generation tourniquet manufactured for BFR by Delphi
  - Automatically measures and sets appropriate pressure
  - Monitors pressure through exercise
  - Automatic shut offs



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## Blood Flow Restriction



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## Blood Flow Restriction



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