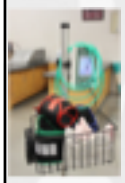
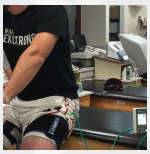
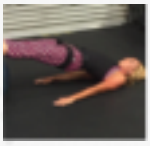
## Blood Flow Restriction (BFR) Therapy



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## Disclosures

- Certified BFR through Ownes Recovery Science
- Not credentialed in KAATSU
- No financial disclosures

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## Brief History of Blood Flow Occlusion?

- First Developed in Japan in1966 Yoshiaki Sato noticed his legs go numb while sitting on the floor in traditional posture and noticed he could barely stand for the blood flow had been blocked to his calves the original "Ah-Ha" moment
- Swelling in Calves was similar to how he felt after he lifted weights with his legs
- Dr. Sato in 1973 developed detail of today's KAATSU as it is currently utilized
  - Dr. Sato rehabbed his broken ankle by applying KAATSU Bands with pressure on and off to his upper leg while doing exercise for 30 secs 3x a day results impressed his MD as his muscles di did not atrophy
- 1994 Sato applied for first patents in Japan, USA and Europe producing first commercially available KAATSU bands
- 1997 Introduced KAATSU Instructor Program

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## Brief History/Overview of Blood Flow Restriction in U.S.

- Johnny Owens, MPT started working in military in sports medicine, but with Operations Iraqi and Enduring freedom there became need for improvements in limb salvage rehabilitation
- Johnny Owens came across blood flow restriction training in the literature, which was a method that would seem to allow a person to increase strength and gain muscle hypertrophy using very light weights.
- Owens Recovery Science & BFR Certification Developed

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## KAATSU Unit is Blood Flow Moderation not BFR

- KAATSU – the devices designed and manufactured by KAATSU Global, Inc. (e.g., KAATSU Nano, KAATSU Master 2.0, KAATSU Air Bands)
  - the KAATSU products are ***not designed to even remotely approach occlusion pressure of arterial flow or do Blood Flow Restriction in a limb.*** (Weatherholt, et al. 2011)
  - The KAATSU equipment was designed and ***is specifically manufactured to avoid arterial occlusion in the limbs.*** (Weatherholt, et al. 2011)
  - This fact is why ***KAATSU was originally defined*** by Dr. Yoshiaki Sato, the KAATSU inventor, and leading Japanese cardiologists at the University of Tokyo Hospital ***as a Blood Flow Moderation (BFM) device***. KAATSU equipment is specifically not a BFR (Blood Flow Restriction) device.

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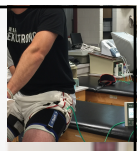
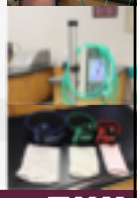
## Delfi Personal Tourniquet System by Owens Recovery Science is Blood Flow Restriction (BFR)

- The Delfi system identifies total occlusion pressure and then applies a specific percentage of that pressure during its applications.
  - The wider cuff of the Delfi Portable Tourniquet System for Blood Flow Restriction is able to restrict arterial blood flow at significantly lower pressures compared to the narrow cuff of KAATSU Air Bands. (Weatherholt, et al. 2011)

***"We were unable to achieve complete arterial occlusion in any participant with the KAATSU cuff."*** **(Weatherholt, et al. 2011)**

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## Physiological Responses Known with BFR Application

- BFR Activates Cori-Cycle using low loads exercise which is known as a result of the lactate build up / rise following application of BFR
- Takarada (2000) compared a load of 20% 1 RM low load exercise with and without a tourniquet only the tourniquet group demonstrated a significant rise in lactate.
- Poton et al (2014) demonstrated levels of blood lactate accumulation were similar between
  - **BFR and exercise at low load (20% 1RM) and High Intensity Training (HIT 80% 1RM).**
  - While control group performed low load exercise (20%1R[redacted] ***BFR*** did not have a significant rise in lactate.

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## Physiological Responses Known with BFR Application

- Increase production of lactate also forces the muscle to use and recruit larger motor units
- Yasuda (2014) Blood lactate concentration at Post was significantly correlated with increased iEMG in both triceps extension($r = 0.65$, $P < 0.01$) and biceps flexion exercises ($r = 0.52$, $P < 0.05$).
- Yasuda (2014) demonstrated doing a typical "rehab" exercise using elastic bands and BFR significantly increased blood lactate vs. controls and subsequently increased iEMG activity.
  - also been confirmed in lower extremity exercise that compared iEMG activity between BFR at 20% 1 RM and work-matched controls (Yasuda 2014 &, Takarada 2000)
- Wilson et. al (2013) found that after 4 sets of low resistance exercise (30% 1RM) ***there is not a significant increase in iEMG without a application of tourniquet.***

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## Physiological Responses Known with BFR Application

- American College of Sports Medicine (ACSM)
  - States " optimizing muscular strength and hypertrophy can be achieved through moderate to high intensities of resistance exercises"
- Donnelly (2009) stated these exercises should target major muscle group's 2-3 days during week with 1 day at a training intensity of more than 65% of a patients 1-rep max.
- ACSM recommended, during resistance training, the load should be >70% of the 1 rep max to achieve maximum muscle hypertrophy

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## Physiological Responses Known with BFR Application

- Takarada (2000) Demonstrated a High intensity training (HIT 80% 1 RM), low intensity BFR (30% 1 RM) and low intensity without BFR (30% 1 RM) demonstrated similar increases in strength between HIT and BFR and both were significantly higher than the low intensity without BFR group.
- Implications for rehabilitation of patients
  - means as a therapist can get strength gains with low load, which patients can tolerate safely or perceive to be easier
  - Including post surgical patients through isometrics and BFR

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## Growth Hormone Response / Stimulus

- Accumulation of lactate build up will stimulate GH response (Goto, 2005, Takada 2000
- Takarada (2000) et al found a large and significant rise in GH after performing low intensity BFR for approximately 10 minutes of exercise.
- Takarada (2000) second group performing low intensity exercise without occlusion and a third group that simply wore a tourniquet did not have a significant rise in growth hormone.
- This finding was re-enforced in Pierce (2006)
- Doessing et al (2010) demonstrated that growth hormone played a direct role in increased collagen synthesis after exercise.

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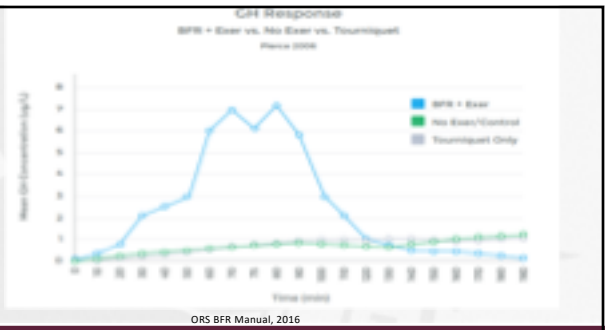


ORS BFR Manual, 2016

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## Myogenic Stem Cell Release

- Myostatin is the switch that allows proliferation of myogenic stem cells to proliferate and allow muscle hypertrophy.
- Decreased myostatin is key for muscular hypertrophy and strength gains and there are two ways to suppress myostatin:
  1. heavy resistance training (HIT)
  2. light resistance training with BFR
- Roth et al (2003) demonstrated a down regulation of myostatin after 9 weeks of heavy lifting up to 85% of a 1 RM.

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## Myogenic Stem Cell Release

- Laurentino et al (2012) measured myostatin markers between 3 groups over 8 weeks.
  1. Group performed low intensity resistance training (20% 1 RM)
  2. Group performed low intensity resistance training (20% 1 RM) with BFR resulted in ↓ Myostatin Levels
  3. Group performed high intensity resistance training (HIT) (80% 1RM) resulted in ↓ Myostatin Levels
- Laourneto et al (2012) study provides evidence that utilization of BFR in rehab or training can lead to increase in muscle hypertrophy and strength with out risk of high intensity training levels

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## BFR Effects on Bone

- Beekley (2005) studied efficacy of BFR on bone using 3 wks of walking with intermittent BFR vs. walking without BFR
  - found that bone specific alkalinephosphate (BAP) a marker of osteoblastic activity was elevated in the BFR group
  - not the control.
- Beekley (2005) also found significant increases in strength and hypertrophy in the thigh muscles of the BFR group. (
- Bemben et al (2007) found a bone reabsorption was significantly lower in a BFR group performing 20% 1 RM knee extensions vs. controls.
- Karabulut (2011) compared 6 wks of BFR leg exercises (knee extension and leg press) at 20% 1 RM to the same exercises at 80% 1 RM demonstrated positive blood bone markers in similar amounts in both groups. (Karabulut 2011)

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## BFR Cardiovascular Benefits

- Abe, T., et al (2010) examined the effects of low-intensity cycle exercise training w and w/o BFR on muscle size and maximum oxygen uptake (VO2max).
  - A group of 19 young men (mean age ± SD: 23.0 ± 1.7 years) were allocated randomly into two groups both which trained for 3days/wk for 8 wks. Groups
    1. BFR-training group (n=9, BFR-training)
       - Training intensity and duration was 40% of VO2max and 15 min for the BFR-training group
    2. Non-BFR control training group (n=10, CON-training),
       - 40% of VO2max and 45 min for the CON-training group.

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## BFR Cardiovascular Benefits

- Abe, T., et al (2010) Continued
  - MRI-measured thigh and quadriceps muscle cross-sectional area and muscle volume increased by 3.4-5.1% ($P < 0.01$)
  - There was no change in muscle size (~0.6%) and strength (~1.4%) in the CON-training group.
  - ***Significant improvements in VO2max (6.4%) and exercise time until exhaustion (15.4%) were observed in the BFR-training group ($p < 0.05$)***
  - No improvements in VO2max and exercise time until exhaustion were not found in the CON-training group (-0.1 and 3. 9%, respectively).
  - ***Suggesting that low-intensity, short-duration cycling exercise combined with BFR improves both muscle hypertrophy and aerobic capacity concurrently in young men.***

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## Integration Into Clinical Practice (ORS Manual 2015 & 2016)

- Utilize Owen Recovery Science Protocols and Experience
- Standard Protocols with Owens Recovery Science for BFR is
  - 30 Reps / 15 Reps / 15 Reps / 15 reps w/ 30 sec rest
  - Cuff stays inflated for entire period
  - Limb Occlusion pressure at 80%
    - May start lower for patient tolerance or until patient is comfortable
- EKU AT's follow the protocols and utilize BFR with all patients for the patients ther ex
- Start BFR as soon as possible and incorporate through entire rehabilitation including return to sport activity
  - Utilized in Weight Room with team activities
  - Indoor Turf with positional exercises
  - Active soft-toss or kick passes

Use 4 sets of 30/15/15/15 with a 30 second rest between sets and a 2-second concentric and 2-second eccentric contraction for a metabolite response.

Volume and a light load is the key for a metabolite response. Manipulate rest periods first if the patient is missing the target.

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## Integration Into Clinical Practice

- Utilize with any ther-ex activity
  - Throwing with throwing athletes
  - Biking activities with Bilateral Cuff Occlusion for Strength and Cardiovascular benefits
  - Utilize 5 min Bike Protocol for new patients to get used to BFR prior to exercise as a warm-up
  - Sport Specific Drills and rehab

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## Integration into Clinical Practice

- Be Creative!!
- Educate your patient of the Benefits
- Patient education of what to expect
- Billing for BFR –
  - Currently no billing codes exist but can bill as therapeutic exercise
  - Patient outcomes and Patient satisfaction is driving healthcare and BFR Results can play a crucial role in this area of your healthcare system

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## Future of BFR ?

- EKU Exercise Physiology lab currently working on a few research areas under Direction of Micheal Lane, PhD, CSCS Associate professor & clinical exercise physiologist
  - Utilizing Base Line Dexa scans to track lean muscle mass increase after injury and BFR's effects on lean muscle mass in limb
  - Effects of BFR on pain catastrophizer's Aaron Sciascia, PhD, ATC & Matt Sabin PhD, ATC
- PRP Injection enhancement through BFR Application prior to draw to increase stem cell and GH - Adam Antz, MD – ASMI

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