SIEVEKING PLASTIC SURGERY

AGELESS SOLUTIONS

TRAINING SMARTER, NOT HEAVIER:
THE SCIENCE OF BLOOD FLOW RESTRICTION

Your Weekly Newsletter
by Dr. Nick Sieveking
June 4, 2026

With our last newsletter ***Building Muscle After the Age of 55***,
we established the importance of resistance training and not only preserving, but increasing, lean muscle mass as we age. Let's be clear about what we mean by "resistance training".

Definition of Resistance Training
Resistance training is a form of exercise where muscles work against an external force or "resistance" in order to:

- Build strength
- Increase lean muscle mass
- Improve bone density
- Enhance balance and mobility
- Improve metabolic health
- Burn calories
- Lose fat stores

The "resistance" can come from:

- Free weights

- Machines
- Resistance bands
- Body weight
- Water resistance

To some, Resistance Training may seem like a fitness strategy reserved for younger, stronger individuals with fewer aches, pains, and orthopedic limitations. Many assume that weight training is safest and more appropriate for those without degenerative joint disease, chronic inflammation, or weakened tendons and ligaments. In reality, the opposite is true. These age-related musculoskeletal changes are precisely why preserving and rebuilding lean muscle mass becomes so important as we age. Muscle is critical not only for strength and mobility, but also for metabolic health, balance, injury prevention, and long-term independence.

Now imagine being able to stimulate muscle growth and strength gains using only 20–30% of the weight normally required during traditional resistance/weight training. This is the foundation of Blood Flow Restriction training — a technique designed to help build muscle while placing far less stress on aging joints, tendons, and ligaments.

2. What Is Blood Flow Restriction training?

Blood Flow Restriction (BFR) training utilizes specialized bands or pneumatic cuffs placed around the arms or legs, depending on which muscle groups are

being targeted during resistance training. Much like a blood pressure cuff, these bands are inflated to a very specific and carefully controlled pressure.

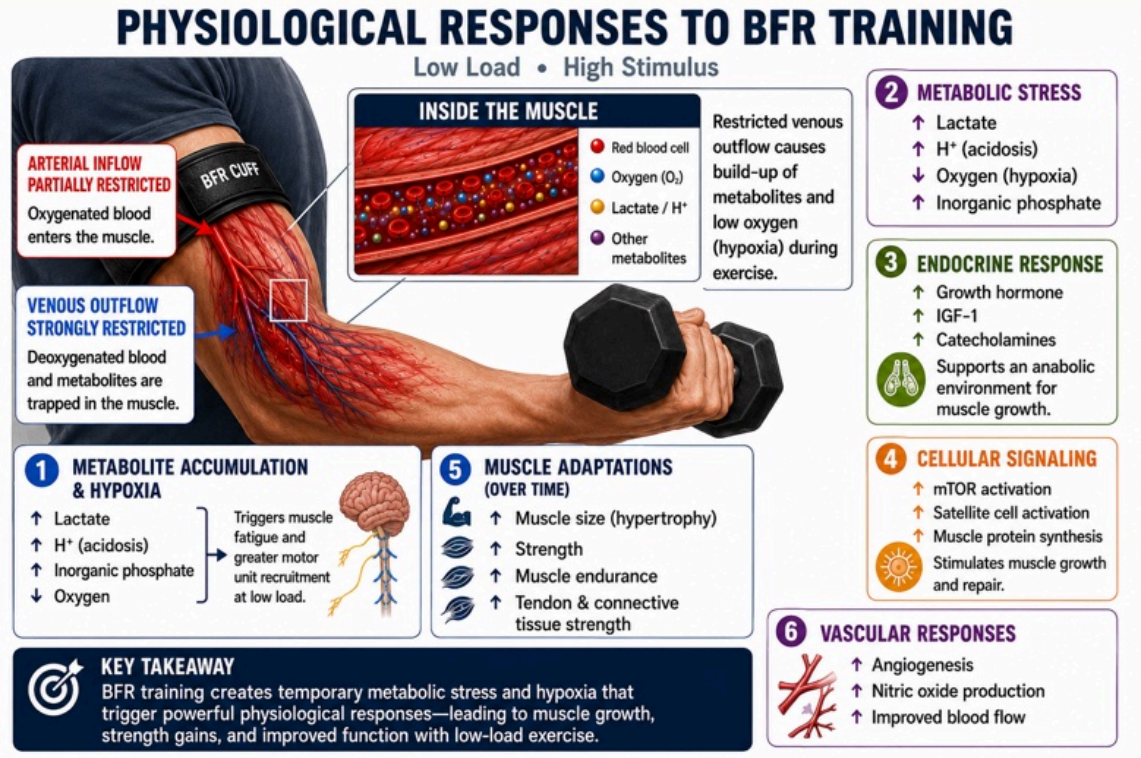
The goal of BFR training is to achieve:

- Partial arterial inflow restriction to a limb
- Significant venous outflow restriction from a limb
- But, NOT complete arterial occlusion

In simpler terms:

- Oxygen-rich blood is still allowed to enter, albeit more slowly, into the limb/muscles through the arteries
- However, blood leaving the muscle through the veins is slowed significantly
- Metabolite-rich blood pools in the “stressed” muscles, initiating muscle – protein synthesis
- The body responds as though the workout were performed with much heavier weights

This oxygen-poor “pooling” effect within the muscle produces a unique low-oxygen (hypoxic), metabolically stressful environment that drives the physiologic response in the muscles associated with BFR training.



As a result, the muscle will stimulate many of the same (and even greater) anabolic and muscle-building pathways seen with traditional heavy resistance training — but while using only 20–30% of the normal training load => less weight = less strain and wear and tear on joints, tendons, and ligaments.

A 2022 Meta analysis of 14 studies showed that low load BFR was superior in muscle building when compared to comparable “non-BFR” resistance training in participants greater than 60 years old (J Clin Med. 2022 Dec 13;11(24):7389.)

This is particularly important for:

- Aging adults
- Individuals with arthritis
- Patients recovering from orthopedic injuries or surgery
- Those with painful or degenerative joints, tendons, and ligaments

Proper Application Matters
Proper application of BFR is critical for both safety and effectiveness:

Arms

- Arm cuffs are placed as high on the upper arm as comfortably possible
- Target muscles:
    1. Biceps
    2. Triceps
    3. Forearm muscles

Thighs

- Thigh cuffs are placed as high on the upper thigh as comfortably possible
- Target muscles:
    1. Quads
    2. Hamstrings
    3. Adductors
    4. Abductors
    5. Lower leg/calf muscles

Modern BFR systems often utilize:

- Calibrated pneumatic cuffs
- Personalized pressure measurements
- Bluetooth monitoring systems
- Individually calculated arterial occlusion pressure

3. What Band Pressures Are Needed for Effective Blood flow restriction training?

Blood pressure is measured in millimeters of mercury (mmHg). A normal blood pressure for most healthy adults is generally considered to be less than 120/80 mmHg.

What Do the Numbers Mean?

Systolic Pressure (Top Number — Example: 120)

- The pressure inside the arteries when the heart contracts and pumps blood

Diastolic Pressure (Bottom Number — Example: 80)

- The pressure inside the arteries when the heart relaxes between beats

Understanding Arterial Occlusion Pressure (AOP)

BFR training works by calculating the **Arterial Occlusion Pressure (AOP)**, (a.k.a. Limb Occlusion Pressure (LOP)) which is the amount of pressure required to completely stop arterial blood flow into a specific limb.

Once the AOP is determined, the training pressure is set below that level in order to:

- Partially restrict arterial inflow
- Significantly restrict venous outflow
- Maintain safety while creating metabolic stress within the muscle

Typical BFR Pressures

Arms

- AOP is commonly around 120-160 mmHg
- Training is typically performed at 40–70% of AOP

Legs

- AOP is commonly around 160-200 mmHg
- Training is typically performed at 60–80% of AOP

It is important to understand that these numbers are only general estimates. Actual arterial occlusion pressures vary significantly between individuals depending on:

Limb size

- Muscle mass

- Blood pressure
- Cuff width
- Tissue composition
- Vascular anatomy

How Is AOP Measured?

Modern BFR systems may utilize:

- Pneumatic cuffs
- Doppler ultrasound
- Built-in pulse sensors
- Automated pressure algorithms
- Bluetooth monitoring systems

These technologies allow users to individualize cuff pressures for improved safety and effectiveness.

Advanced Pneumatic Systems
Pneumatic **BFR** systems capable of precisely measuring arterial occlusion pressure are commercially available and typically range from a few hundred dollars to over $1,000.

These systems offer:

- Personalized pressure calibration
- Automated monitoring

- Greater precision
- Improved safety profiles

Blood Flow Restriction (BFR) Brands and Approximate Pricing

Brand	Type	Approx. Price (USD)
SAGA Fitness	Wireless Auto-Calibrating	$388–668
SmartCuffs 4.0	Wireless with LOP Calibration	$435–499
LiveBand	Wireless BFR Cuff	$200
B Strong	Inflatable Manual	$320–480
RockCuff	Manual Inflatable	$149
AirCuff 2.0	Manual Inflatable	$99–109
KAATSU	Electronic Clinical/Consumer	$500–2,000+
Delfi	Clinical Gold Standard	$4,000–10,000+
Generic Occlusion Bands	Elastic Bands	$15–50

I personally use the SAGA Fitness arms and thigh cuffs. I find the bands comfortable at higher pressures. And the smartphone application is very accurate and easy to use.
For ***20% off the SAGA Fitness BFR system, go to saga.fitness.com and use promo code "AGELESS".***

Automated Cuffs are expensive. Can Manual BFR bands be used? Even If Exact AOP Cannot Be Measured?

When precise arterial occlusion pressure cannot be determined:

- Lower pressures are generally safer than excessive pressures
- Wider cuffs require less pressure => Narrow cuffs require higher pressure and can injure blood vessels and nerves
- Gradual progression of pressure application is safest over several workout sessions.
- Monitoring symptoms carefully is critical

Manual BFR Bands

Manual **BFR** bands and elastic wraps are widely available online, for approximately $30.

Although these devices can still produce an effective training response, they do not allow:

- Exact measurement of arterial occlusion pressure
- Precise pressure calibration
- Real-time monitoring of blood flow restriction

As a result, users must rely more heavily on experience, symptom monitoring, and conservative pressure application.

Warning Signs of Excessive Pressure

The following symptoms are not considered normal during BFR training:

- Numbness
- Tingling
- Severe pain
- Pale or cold extremity
- Loss of distal pulse

If these occur, cuff pressures should be reduced immediately or training discontinued.

Personal Note: I have used “manual“ BFR bands for A few years before I invested in the automated Bluetooth bands that sync with your phone. With the manual bands, I always aired on the “safe side“ utilizing what I perceived to be lower pressures- no numbness, no tingling, no blue fingers or toes. And with that, I did experience great results from my “manual BFR”. Now that I have gone “automated”, I have been able to safely increase band pressures and experience more exhaustive workouts.

Why Proper Pressure Matters

If Pressure Is Too Low:

- Adequate metabolic stress may not occur
- Muscle-building pathways may not be sufficiently activated
- The physiologic benefits of BFR may be reduced

If Pressure Is Too High:

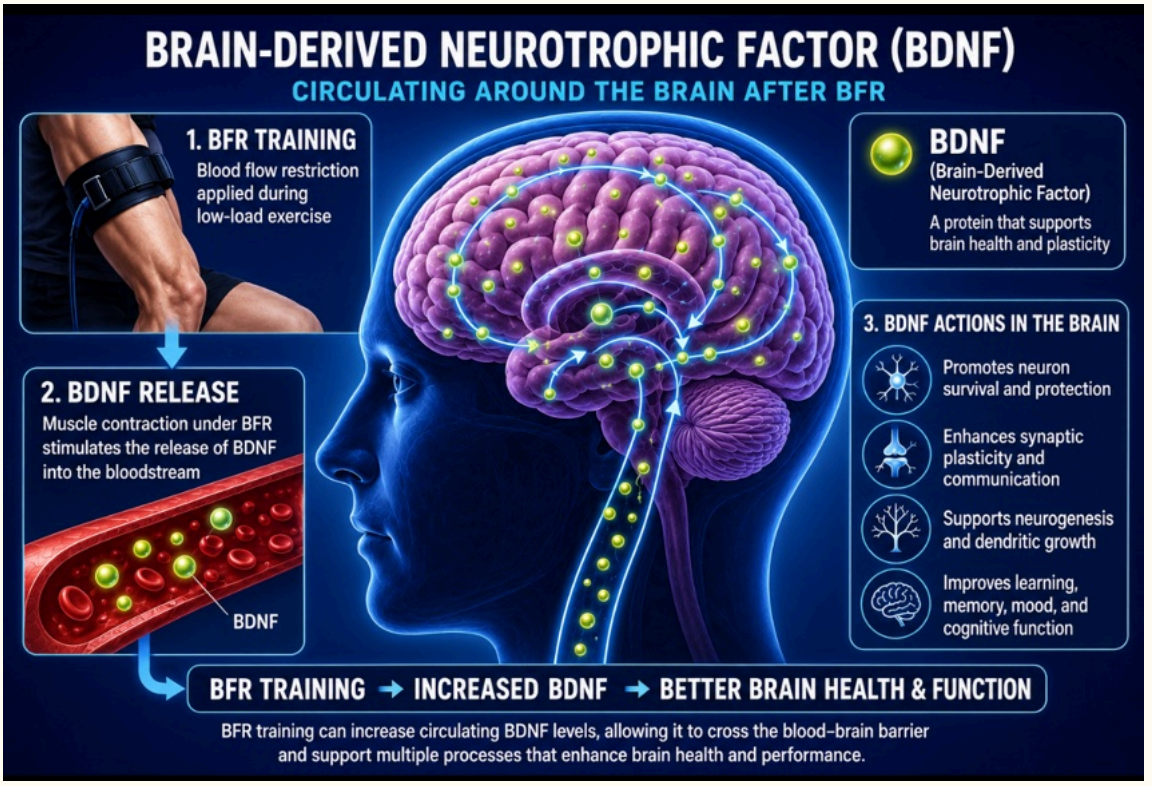
- Excessive ischemia may occur
- Nerve compression becomes more likely
- Pain and tissue irritation may increase
- Risk of complications rises significantly

The Three Core Drivers of the BFR Advantage:

- Hypoxia (oxygen depleted muscles)
- Mechanical Stress and Cellular Swelling (within the muscles themselves)
- Metabolic Stress and Metabolite Accumulation (which has systemic effects)

1. Hypoxia (Low Oxygen Environment)
Partial restriction of blood flow creates a temporary oxygen deficit within the working muscle. This hypoxic environment triggers several beneficial adaptations.

A. Increased BDNF (Brain-Derived Neurotrophic Factor)
BDNF is often referred to as "fertilizer for the brain."



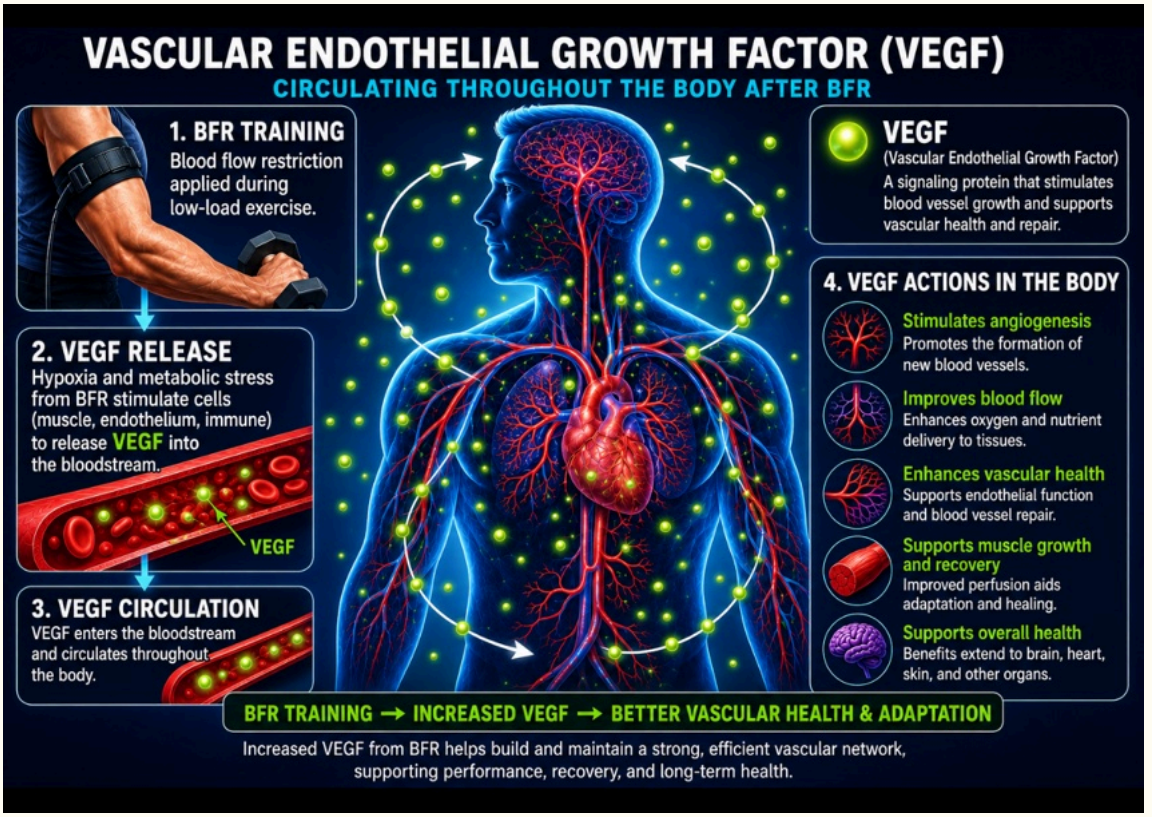
Benefits:

1. Supports growth and survival of neurons
2. Improves learning and memory
3. Enhances neuroplasticity and nerve regeneration
4. Protects against age-related cognitive decline
5. Supports mood and mental health

B. Increased VEGF (Vascular Endothelial Growth Factor)
VEGF stimulates angiogenesis (new blood vessel formation).

Benefits:

1. Increased capillary density
2. Improved muscle oxygenation
3. Enhanced nutrient delivery
4. Improved endurance
5. Improved vascular health
6. Enhanced tissue repair and recovery

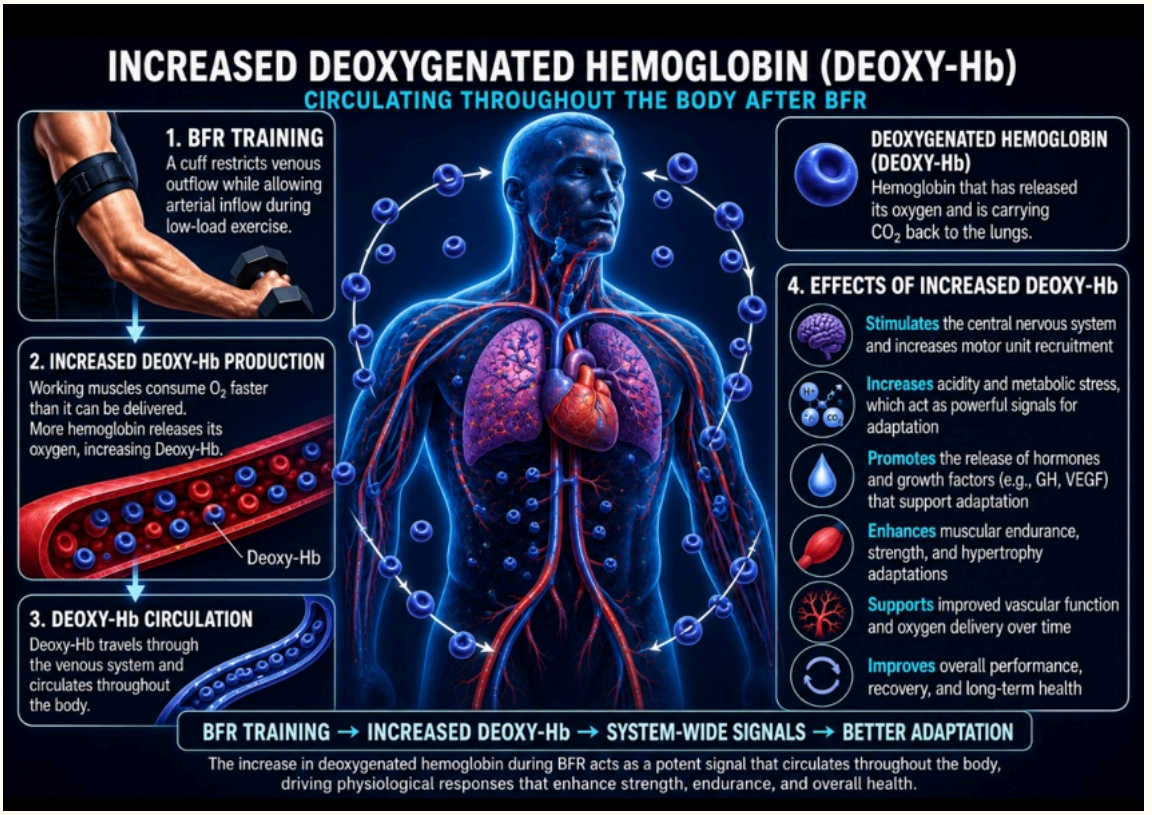


C. Increased Deoxygenated Hemoglobin => oxygen-depleted red blood cells

Reflects increased oxygen extraction within working muscle.

Benefits:

1. Stimulates angiogenesis→ new blood vessel formation and enhanced blood flow
2. Promotes pulmonary adaptation→ enhanced lung functioning capacity
3. Enhances oxygen utilization efficiency to all organs and tissues
4. Mechanical Stress and Cellular Swelling



As muscles repeatedly contract against resistance while venous blood flow is restricted, blood and fluid become trapped within the muscle.

Sequence:
→ Mechanical Stress
→ Blood Pooling (Congestion)
→ Cellular Swelling ("The Pump")
→ **mTOR*** Activation
→ Muscle Protein Synthesis
→ Muscle Growth
***mTOR** (Mammalian Target of Rapamycin) =The master regulator of muscle growth.

Functions of **mTOR**:

1. Stimulates muscle protein synthesis
2. Activates satellite cells (stem cells in muscle) → muscle fiber repair
3. Promotes muscle repair and hypertrophy
4. Increases strength and lean body mass
5. Benefits of Cellular Swelling→ enhances, nutrient delivery and signals growth factor release
6. Increased anabolic signaling→ muscle growth
7. Reduced protein breakdown
8. Enhanced muscle growth
9. Greater training adaptations despite light loads

3. Metabolic Stress and Metabolite Accumulation=> Systemic Effects
Because venous blood is partially restricted, metabolites accumulate rapidly within the working muscle. This metabolic stress is one of the major drivers of

BFR's benefits.

Major Signaling Molecules Produced During BFR:

A. Lactic Acid (Lactate)=> a major metabolite

Once considered a waste product, lactate is now recognized as a powerful signaling molecule.

Benefits:

1. Increases Growth Hormone
2. Recruits Fast-Twitch Muscle Fibers => great for sprinters, rowers, jumpers
3. Activates mTOR and Muscle Protein Synthesis
4. Promotes Cellular Swelling
5. Increases BDNF
6. Stimulates VEGF and Angiogenesis
7. Enhances Mitochondrial Function
8. Improves Insulin Sensitivity

Personal note: I check my lactic acid levels with a lactic acid meter before and after my BFR workouts. It's not uncommon for my lactic acid to increase from 8 mg/dL to over 70 mg/daL after a 30 minute BFR workout.

B. Nitric Oxide (NO)=> a major metabolite

The body's natural vasodilator.

Benefits:

1. Improves blood flow and circulation
2. Enhances oxygen and nutrient delivery
3. Supports muscle growth and recovery
4. Promotes angiogenesis
5. Improves endothelial function→ lowers blood pressure and protects blood vessels from plaque
6. Supports mitochondrial function→ enhanced energy production
7. Improves insulin sensitivity
8. Aids tissue repair and healing

C. Additional Metabolic Byproducts and Their Benefits

1. Hydrogen Ions (H^+)

Benefits:

- Stimulate growth hormone release
- Increase fast-twitch muscle fiber recruitment→ improves power, overall strength, and speed
- Amplify hypertrophic signaling→ muscle growth

2. Inorganic Phosphate (Pi)

Benefits:

- Contributes to strength adaptation
- Promotes hypertrophy signaling
- Helps create the fatigue stimulus necessary for growth

3. Dihydrogen Phosphate

Benefits:

- Enhances fast-twitch fiber recruitment
- Supports hypertrophic signaling

4. Carbon Dioxide (CO_2)

Benefits:

- Stimulates chemoreceptors→ increases heart rate and increases respiratory rate during training sessions
- Enhances cardiovascular adaptation→ cardiac conditioning
- Promotes respiratory conditioning→ increases lung capacity

5. Adenosine

Benefits:

- Improves blood circulation
- Enhances nutrient delivery to vital organs
- Supports recovery signaling

6. Adenine

Benefits:

- Promotes mitochondrial enhancement
- Improves muscular energy, ATP production, and storage
- Dilates blood vessels and improves blood flow

7. Hypoxanthine

Benefits:

- Stimulates mitochondrial health and enhanced energy production
- Enhance his blood flow to vital organs
- Improves overall endurance

8. AMP / ADP Signaling → Indicators of cellular energy demand.

Benefits:

- Activates AMPK pathways→ more fat burning and energy conservation
- Stimulates mitochondrial biogenesis
- Improves metabolic efficiency

- Enhances fatigue resistance

OTHER METABOLITES:

9. Superoxide (O_2•−) → Stimulates adaptive muscle remodeling

10. Hydrogen Peroxide (H_2O_2) → Promotes mitochondrial biogenesis & Upregulates antioxidant defenses

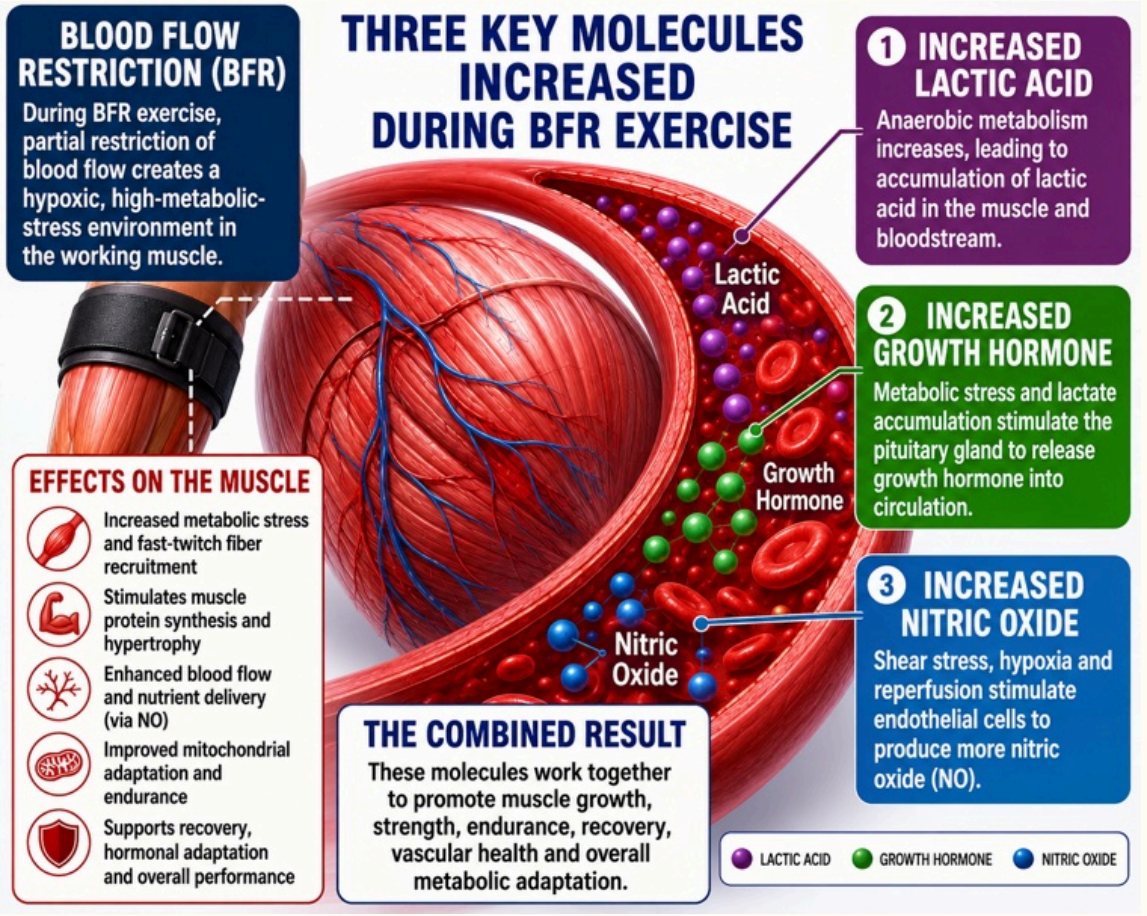
11. Glutathione Metabolites (GSH/GSSG) → Support redox balance & Protect cells from oxidative damage

12. Organic Hydroperoxides → Contribute to adaptive stress signaling & Support cellular resilience

13. Increased Free Fatty Acids (FFAs) → BFR stimulates growth hormone release and fat mobilization.

Benefits:

- Increased fat utilization
- Improved metabolic flexibility
- Enhanced insulin sensitivity
- Improved body composition
- Additional fuel source during recovery



Summary: Advantages of Blood Flow Restriction (BFR) Training

Muscle Growth & Strength

- Increases muscle hypertrophy with light weights
- Enhances muscle protein synthesis
- Activates mTOR signaling
- Recruits fast-twitch muscle fibers
- Helps preserve muscle during injury or aging

Hormonal Response

- Increases growth hormone release
- Stimulates IGF-1 production
- Enhances anabolic signaling

Metabolic Benefits

- Increases lactate production and metabolic stress
- Improves insulin sensitivity and glucose uptake
- Enhances metabolic flexibility
- Increases fat mobilization and oxidation
- Improves mitochondrial function and energy production

Vascular Benefits

- Increases nitric oxide production
- Improves blood flow and circulation
- Enhances endothelial function
- Promotes angiogenesis (new blood vessel growth)
- Increases capillary density
- Improves oxygen delivery and utilization

Endurance & Conditioning

- Improves muscular endurance
- Enhances fatigue resistance
- Increases aerobic adaptations
- Improves exercise capacity with lower training loads

Recovery & Tissue Health

- Enhances tissue repair and recovery
- Supports tendon and ligament health
- Reduces muscle breakdown
- Increases recovery signaling pathways

Brain & Nervous System Benefits

- Increases BDNF (Brain-Derived Neurotrophic Factor)
- Supports learning and memory
- Enhances neuroplasticity
- May help protect against age-related cognitive decline

Bone & Healthy Aging Benefits

- May stimulate bone remodeling and osteoblast activity
- Helps maintain muscle mass with aging
- Provides high physiologic stimulus with minimal joint stress

Bottom Line

BFR allows individuals to achieve many of the benefits of heavy resistance training while using only 20–30% of their maximum lifting capacity, making it a powerful tool for muscle growth, recovery, vascular health, metabolic fitness, and healthy aging.

STAY TUNED!

Be on the lookout for next week's newsletter, *"Testosterone Replacement for Men and Women: Why Can't Your Doctor Get it Right?"*

Newsletter Archives

Sieveking Plastic Surgery
1200 Old Hillsboro Rd., B2,
Franklin, TN 37069
info@sievekingplasticsurgery.com
615-321-1010

Ageless Solutions
615-678-7784