Blood Flow Restrictive Training

Muscle Growth at any Age

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Author's Advice

Muscle growth at any age is based on extensive scientific research. The book contains instructions and safety cautions, and you are urged to read them carefully. Prior to beginning this exercise program, you must be examined by your physician and obtain his or her approval. Remember that regular medical checkups are essential for your health and well-being. While this book can serve as your guide to growing stronger and becoming more physically active, it cannot replace the advice of a health care professional who is familiar with your medical problems and medications that you are taking. Please consult with your physician prior to starting this program.

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HISTORY OF BLOOD FLOW RESTRICTIVE TRAINING (BFR)

BFR was first described in 1937 in the Journal of American Medicine. At that time it was not used for building muscle, but was used to regenerate tissue and increase walking capacity in patients with poor circulation in their legs. Later, in the 1960s, Yoshiaki Soto, M.D., a Japanese weightlifter, sat in an hours-long Buddhist ceremony in the "Seiza" posture. This position is where the thighs are folded onto the shins. When Yoshiaki stood up from the Seiza position, he felt his calves throbbing and was intrigued by this finding at the young age of 18.

Seiza Position

Later, in 1966, he suffered a fracture of his leg and was immobilized in a cast for 6 weeks. At that time he placed bands around his thigh and did isometric contractions. Six weeks later, he returned to his physician who changed the cast, and to everyone's surprise he had no atrophy (decrease in size of his leg).

Normally, disuse of a limb leads to muscle loss and atrophy. Atrophy and loss of strength occurs at a rate of 2% per week. Type 1 and Type 2 muscle fibers can atrophy by over 14% and 17% in only 72 hours of limb immobilization. Dr. Soto knew that quadriceps muscle atrophy cannot be reversed through the use of isometric exercise alone. He created a new concept of healing, by preventing atrophy by putting a band around his thigh while immobilized and doing isometric exercise. He then spent the next 40 years experimenting with different ways to restrict flow including bike tire tubes, ropes, judo belts and finally pneumatic bands. Once he attached the pneumatic bands to a digital control system, he was then able to accurately monitor pressure and restrict blood flow. He named his machine the Kaatsu (Japanese for "additional pressure"). He is now considered the "Father of BFR."

HOW BLOOD FLOW RESTRICTION (BFR) WORKS

Dr. Soto – Inventor of Kaatsu or BFR

Blood flow restriction (BFR) training involves very slightly restricting arterial inflow and slowing of venous outflow from the muscle group being exercised. The band needs to be tight enough to slow venous return to the heart, while loose enough to allow arterial blood to flow-through. This restriction of venous outflow creates a hypoxic (low oxygen) environment. This hypoxia causes the influx of hydrogen ions which lowers the pH of the cell, causing fatigue and the familiar muscle burn of intense exercise. Lactic acid is then formed and acts like a hormone by stimulating the release of testosterone and human growth hormone. Testosterone and human growth hormone are key players in human metabolism, especially as they pertain to physique development, combating obesity, and anti-aging effects. Testosterone and human growth hormone both increase lean muscle and decrease fat mass. These hormone effects are more pronounced with anaerobic exercise.

HOW BFR WORKS LOCALLY IN MUSCLE

Locally in the muscle you will restrict (but maintain) arterial inflow, but you will occlude venous outflow. The application on exercise with muscles whose blood-flow is restricted is very important. The contraction of your muscle during exercise will push venous blood past the obstruction created by the BFR bands back into the central circulation. The venous valves in the veins prevent blood from flowing back into the exercising muscle. Then with muscle contraction the arterial blood fills the emptied peripheral vessels and muscle space. In this way, the blood flow to the working muscle is still maintained. Even though the arterial flow to the muscle is maintained, the oxygen concentration is decreasing due to increased demand of the exercising muscle for oxygen. There is a significant deficit of oxygen when compared to the normal state because blood flow is restricted.

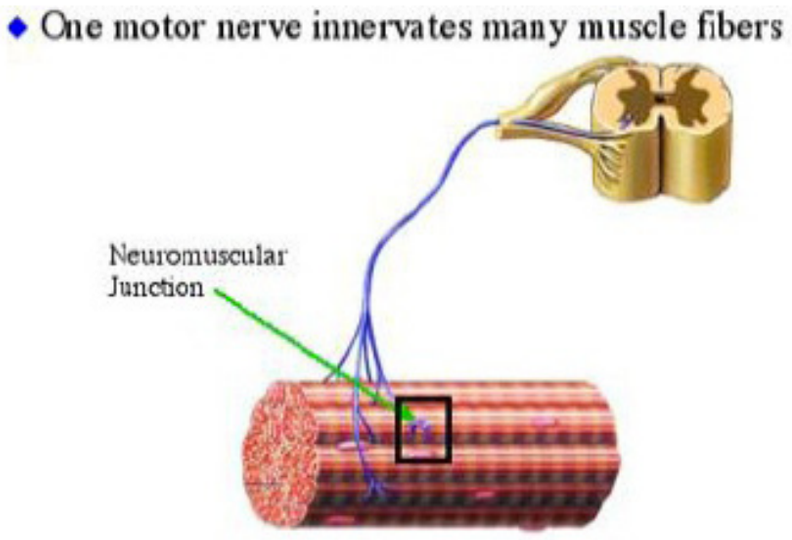
Summary of BFR in muscle

1. Proximal Venous Obstruction is present and results in restricted circulation at rest. Pressure builds as arterial blood continues to pump into the limb.
2. Vascular distension occurs due to blood filling the vessel.
3. Muscular contraction pushes venous blood past the obstruction by the BFR bands back into central circulation.
4. During rest between the sets, the artery fills the limb with blood, but the flow is reduced due to restriction by the bands.
5. Metabolic crisis occurs and lactate and oxygen are produced followed by anabolic hormones.

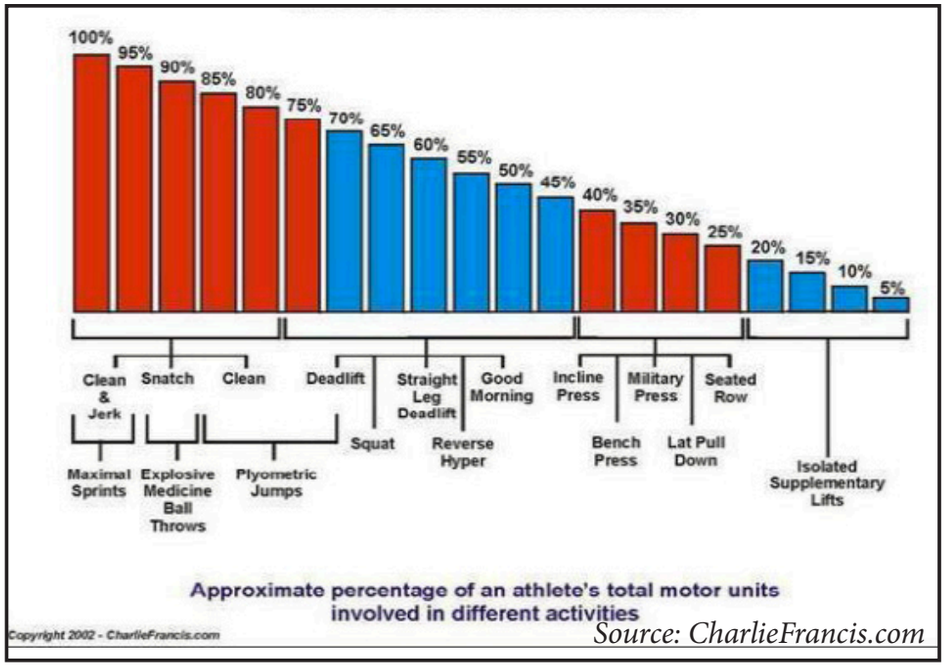
In order to increase muscle mass and strength, it is important to activate the type 2 muscle fibers. These fibers are larger than the type 1 fibers and are more responsive for increasing muscle size than type 1 fibers. During BFR training, the type 1 fibers become highly fatigued during the first set of exercise due to lack of oxygen, thus necessitating the recruitment of type 2 fibers that cause the production of lactate, which increases our fitness hormones such as growth hormone and testosterone. Simply moving light weights with high repetition without BFR will not engage type 2 fibers because there is plenty of oxygen for the type 1 fibers to work. It requires an anaerobic (without oxygen) environment to activate type 2 muscle fibers.

Source: Mercola.com

MOTOR UNIT RECRUITMENT LOCALLY



A motor unit consists of one motor neuron and all of the muscle fibers it stimulates. Motor units are recruited based upon the "size principle" from smallest (type 1 fibers) to largest type 2 fibers. The activation of more motor neurons results in more muscle fibers being activated. The more fibers recruited the stronger the muscle contraction.



Source: CharlieFrancis.com

When you look at the graph to the right, it is important to understand that when you do small lifts such as arm curls or triceps extension you are only activating 10 to 15% of your motor units. If we want to get bigger with more muscle growth we have to recruit more motor units such as with sprinting or doing a clean and jerk movement. This would result in 90-100% recruitment of motor units. In the elderly or in a rehabilitation program, you will not be able to recruit enough motor neurons since they cannot do this strenuous type of exercise. This is where BFR training is a game-changer by activating numerous motor units with only doing light weights.

mTOR PATHWAY WORKS LOCALLY

By forcing your blood to remain inside your muscles longer than normal, you force more rapid muscle fatigue and muscle failure. This stimulates subsequent repair

and regeneration processes. The mTOR pathway is upregulated to increase protein synthesis and muscle growth. The mTOR pathway also inhibits myostatin which is a protein produced by your muscle cells that inhibits muscle growth.

MYOSTATIN INHIBITS MUSCULAR GROWTH

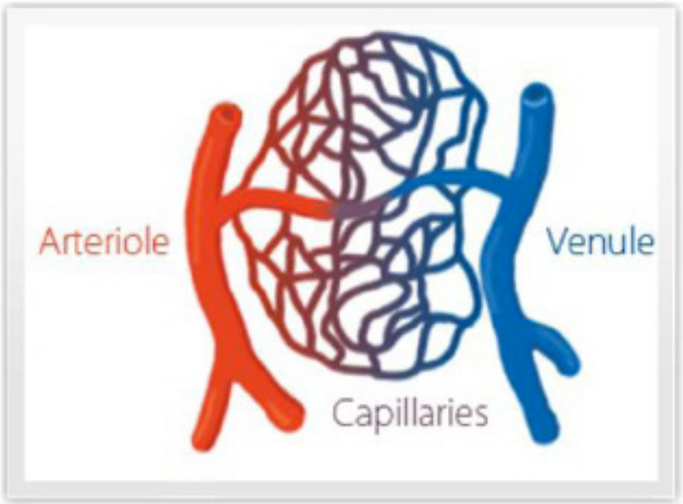
As we age, a hormone called myostatin increases which can inhibit muscle growth. This is important because the elderly have levels that are twice as high as young individuals. The good news is that the mTOR pathway that is produced during BFR can down-regulate the production of myostatin, which will decrease skeletal muscle loss. Amazingly, BFR can decrease your myostatin levels by 45%, which has been shown to increase muscle protein synthesis.

SYSTEMIC EFFECTS OF BFR

The rising lactic acid levels can penetrate into the brain and signal a crisis that needs to be handled immediately. The central nervous system responds and activates your autonomic nervous system which increases sympathetic tone, heart rate, breathing and sweating. What makes BFR unique is it fools the brain into thinking that it is being put through a vigorous workout. This activates the hormones that are involved in repair processes throughout your body. They facilitate protein synthesis and muscular growth.

A. VEGF – VASCULAR ENDOTHELIAL GROWTH FACTOR

This is elevated in cell swelling with BFR. It is responsible for promoting the growth of new vessels (angiogenesis), which aids in muscle and bone growth. It also aids in the healing process to allow growth (hypertrophy) with resistant training.



MICROCIRCULATION

BFR increases your microcirculation, which allows blood flow through the smallest vessels in the circulatory system (arterioles, venules and capil-

laries). The hypoxic environment created by BFR stimulates the release of VEGF (vascular endothelial growth factor), which is one of the most powerful blood vessel producing signals in your body. Essentially VEGF acts like "Miracle Grow" for increasing new blood vessels and capillaries to your muscle cells. BFR training has been shown to increase muscle stem cells by 300% after eight days of training.

B. HIF – HYPOXIA INDUCIBLE FACTOR

This is considered the master regulator of cellular response to hypoxia. It is known to induce transcription of more than 60 genes including VEGF and erythropoietin which both assist in promoting and increasing oxygen delivery to hypoxic regions. The new vessels form from pre-existing vessels which create more oxygenated blood in the muscle and allows more deoxygenated blood and waste to leave the muscle.

EPO (erythropoietin) has a long history of abuse in endurance sports. EPO has been used to increase one's red blood cell mass, which allows the body to transport more oxygen to the muscles and therefore increase stamina and endurance. EPO thickens the blood, which "leads to an increased risk of several deadly diseases, such as heart disease, stroke, and pulmonary embolism." Athletes who misuse recombinant human EPO are also at risk of serious autoimmune diseases. This has been called "blood doping" and is banned by the International Olympic Committee. The good news is we can produce this naturally by doing BFR training.

C. NITRIC OXIDE

Nitric oxide is called the "miracle molecule" and is produced with BFR training. It causes vasodilation, meaning it relaxes the inner muscles of the blood vessels, causing them to widen and increase circulation. BFR largely improves endothelial function. The endothelium refers to the thin layer of cells that line the blood vessels. These cells produce nitric oxide, which keeps the blood vessels healthy. Insufficient nitric oxide results in endothelial dysfunction, which can contribute to atherosclerosis, hypertension and heart disease. Nitric oxide is essential for overall health and allows blood, nutrients and oxygen to flow to every part of your body.

D. LACTATE

It is the byproduct of anaerobic metabolism. Lactic acid breaks down into lactate and hydrogen. Lactate is a biomarker of fatigue and is responsible for the fatigue and "burn" feeling with exercise. Lactate sends signals to the brain that causes the release of anabolic hormones such as human growth hormone, testosterone and IGF-1. It enhances the human oxidative capacity by increasing skeletal muscle mitochondria production. The mitochondria are called the "powerhouse of the cell," since they produce ATP which is the main energy source used by your cells.

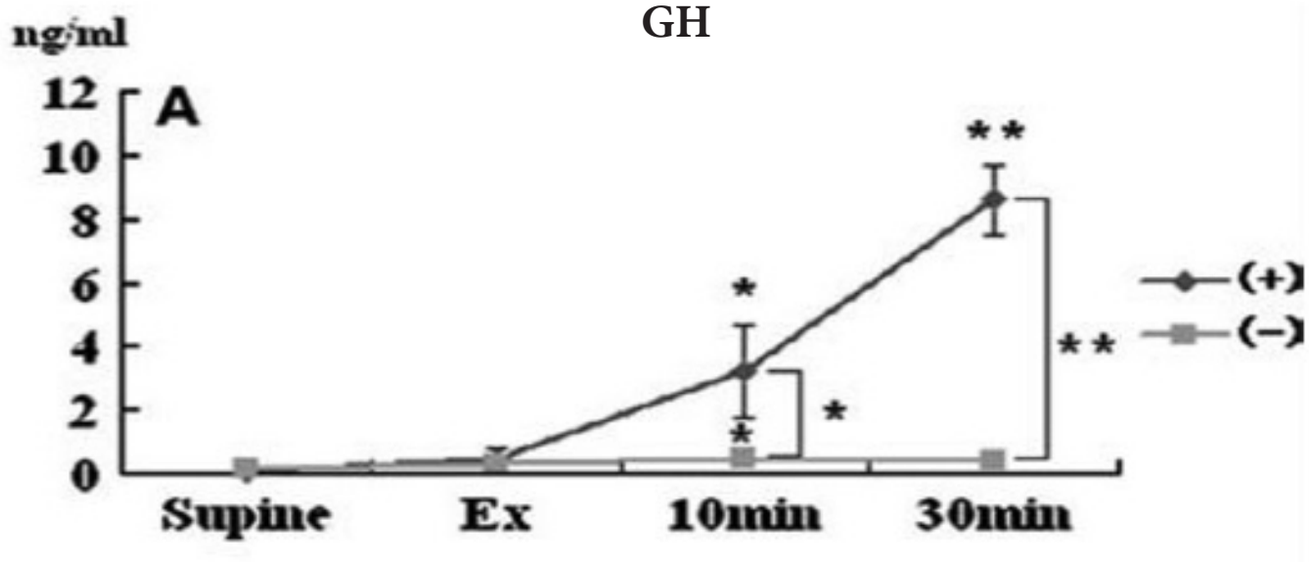
E. HYDROGEN

Hydrogen is the byproduct of anaerobic metabolism. Lactic acid breaks down into lactate and hydrogen. The accumulation of hydrogen lowers the ph inside the muscle and makes it more acidic.

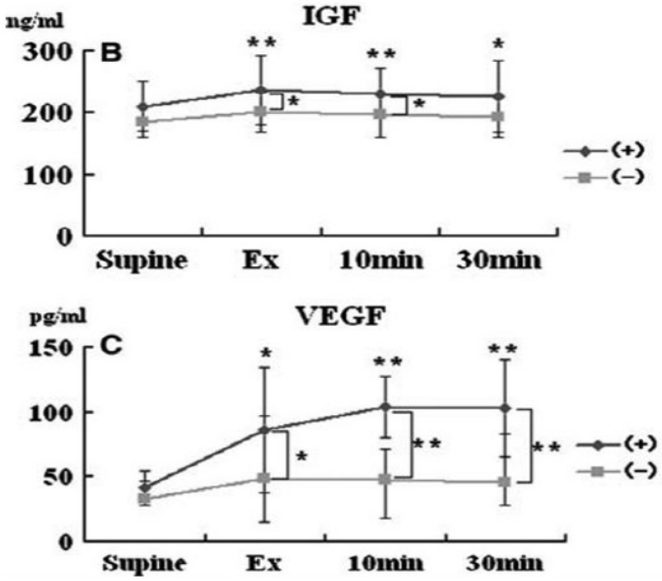
F. GH – GROWTH HORMONE

Growth hormone stimulates muscle growth and regeneration. It is anabolic (stimulates growth) and lipolytic (breaks down fat). GH stimulates insulin like growth factor (IGF) which has stimulatory effects on osteoblast and chrondocytes to promote bone growth. Also, IGF can significantly increase muscle growth and has been called the muscle mass regulator.

The graph below shows the increase in GH, VEGF and IGF during BFR training



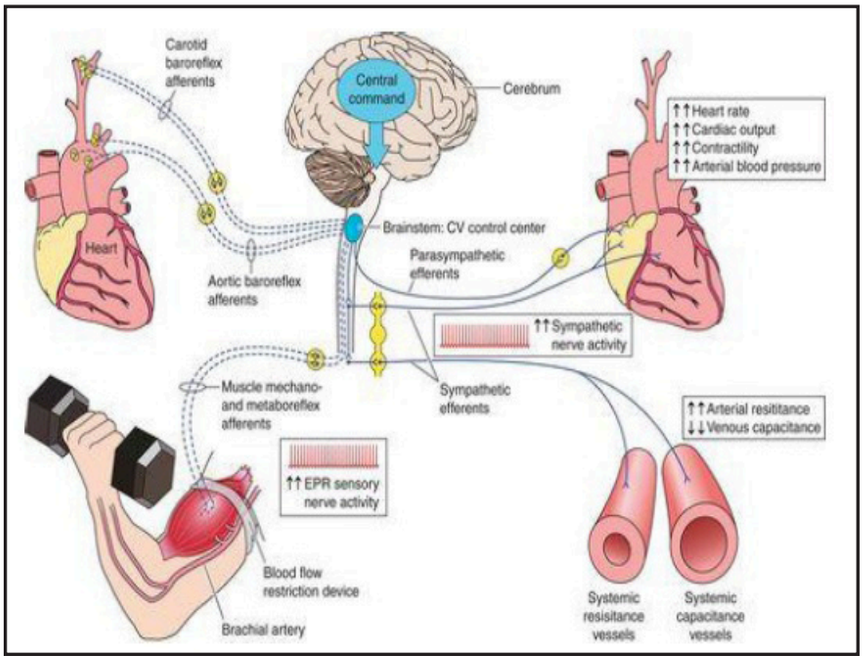
with same reps and exercises. The control group without BFR on the graph below had a poor response to the same hormones. These factors are very important in healing following surgery and rehabilitation.



G. TPA – TISSUE PLASMINOGEN ACTIVATOR

This is a protein found in the endothelium involved in breakdown of blood clots. TPA is naturally released in the body with exercise and has fibrinolytic (inhibition of clot formation) activity. Increases in TPA activity are related to the intensity and duration of an exercise activity. A greater amount of TPA will be released if the exercise is more intense. This may explain why exercise helps to decrease the risk of heart attack and stroke. Since, BFR produces TPA; this will decrease the risk of blood clots.

H. BFR CREATES WHOLE BODY EFFECT = VASCULAR + MUSCULAR + NEUROLOGICAL



During exercise with BFR bands attached, muscular contraction creates fatigue. The fatigue is associated with increased lactate production and the muscle starts burning and sends crisis signals to the brain which activates the sympathetic nervous system. This increases heart rate, sweating, shortness of breath, and blood pressure. Anabolic hormones such as human growth hormone, testosterone and IGF are produced that increase protein synthesis and muscle

hypertrophy. The vascular system is activated and VEGF and nitric oxide are produced which dilates the vessels and creates angiogenesis (new vessel growth).

I. COGNITIVE IMPROVEMENT WITH BFR TRAINING

Also, lactic acid increases a powerful hormone called brain derived neurotrophic factor (BDNF). BDNF helps produce new brain cells and strengthen existing ones. It plays an important role in survival of your neurons. Decreased levels of BDNF are associated with neurodegenerative diseases such as Parkinson's disease, Alzheimer's disease and multiple sclerosis. This increase in BDNF does account for cognitive improvement in people doing BFR training.

BDNF produces new brain cells and strengthens existing ones

BFR AND SARCOPENIA

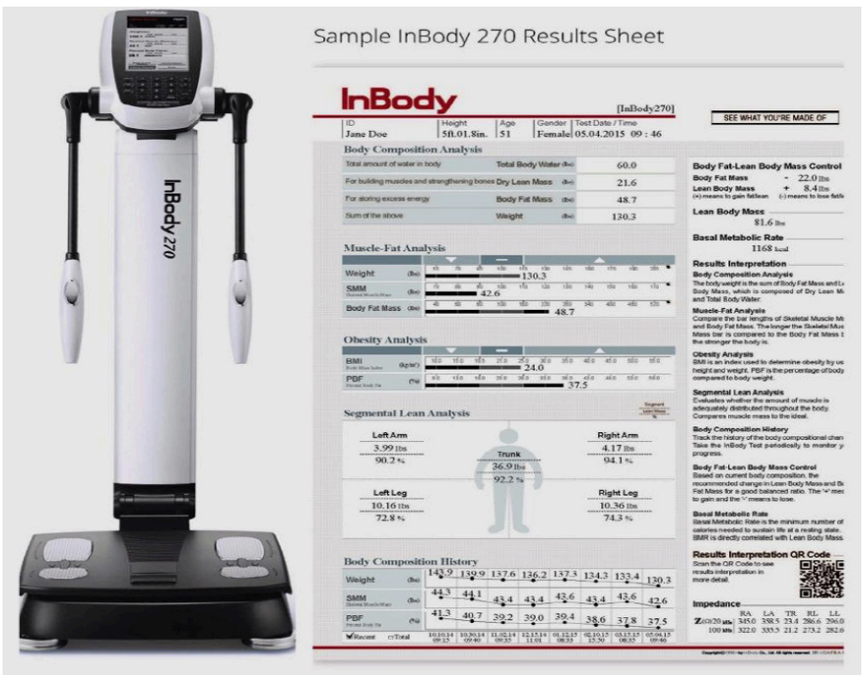
Our muscle is essentially an organ that plays an essential role in supporting a strong metabolism. The loss of muscle mass (sarcopenia) is linked to many chronic diseases. After the age of 30, we begin to lose muscle mass and function. Physically inactive people can lose as much as 5% of their muscle mass each decade after 30. Even if you are active, you still can have some muscle loss. This process can speed up after age of 65 and is a factor in frailty and the likelihood of falls and fractures in older adults.

People with sarcopenia experience weakness and lose stamina. They have trouble carrying out normal daily activities. This means that regular tasks such as getting out of bed, standing up from chairs, and climbing stairs can become very difficult. The end result is less movement which speeds up muscle loss. The sedentary lifestyle leads to a greater risk of osteoporosis.

Muscle strength also decreases with advancing age and to a greater degree than muscle mass. Muscle atrophy associated with sarcopenia appears to result from a gradual and selective loss of muscle fibers and motor neurons, accompanied by fatty infiltration of the muscle. The muscle histology in the elderly shows an unusual fiber-type distribution. The aging-related decline in fiber size and number affects type 2 muscle fibers to a greater extent than type 1 muscle fibers. Sarcopenia is characterized by the atrophy of type 2 muscle fibers and a reduction in muscle-fiber satellite cells with aging. Satellite cells are stem cells capable of building new muscle.

SARCOPENIA AND INSULIN RESISTANCE

It well known that very low muscle mass (sarcopenia) is a risk factor for insulin resistance. The good news is that having more muscle mass may protect against insulin resistance and pre-diabetes. Our skeletal muscle is a storage tank for 80% of the glucose in our body. It removes the sugar out of our blood stream to prevent complications such as diabetes, neuropathy, dementia, obesity and myocardial infarction.



A study published in the Journal of Clinical Endocrinology and Metabolism found that for every 10% increase in the ratio of skeletal muscle mass to total body weight was associated with an 11% reduction in risk of insulin resistance and a 12% drop in risk of pre-diabetes or overt diabetes. These findings point to the importance

of gauging skeletal muscle mass in addition to traditional risk factors when assessing for metabolic syndrome. Muscle mass can be easily accessed via bioelectrical impedance where an electrical current flows through the body to estimate body composition. We record skeletal muscle mass using the InBody machine shown on previous page.

BFR MIMICS HEAVY WEIGHT TRAINING WITHOUT THE RISKS

BFR is unlike a conventional resistance training program that uses heavy weights and low repetitions. Typically, when you're doing conventional strength training, you're working with weights in the range of 60% to 85% of your one-rep max. In BFR, you're using no more than 30% of your one-rep max. Low weight is actually one of the key aspects of effective BFR. The second key is a high number of repetitions. Rather than doing just six or 8 reps, you're doing 30 reps in the first set.

BFR TRAINING IS PERFECT FOR THE ELDERLY

BFR is superior to conventional weight training in the elderly. Most elderly cannot engage in high intensity exercise or heavy weight lifting, due to the decrease in the microcirculation with aging. The capillary growth is diminished, which decreases the blood supply to the type 2 muscle fibers which are essential to maximize muscle growth.

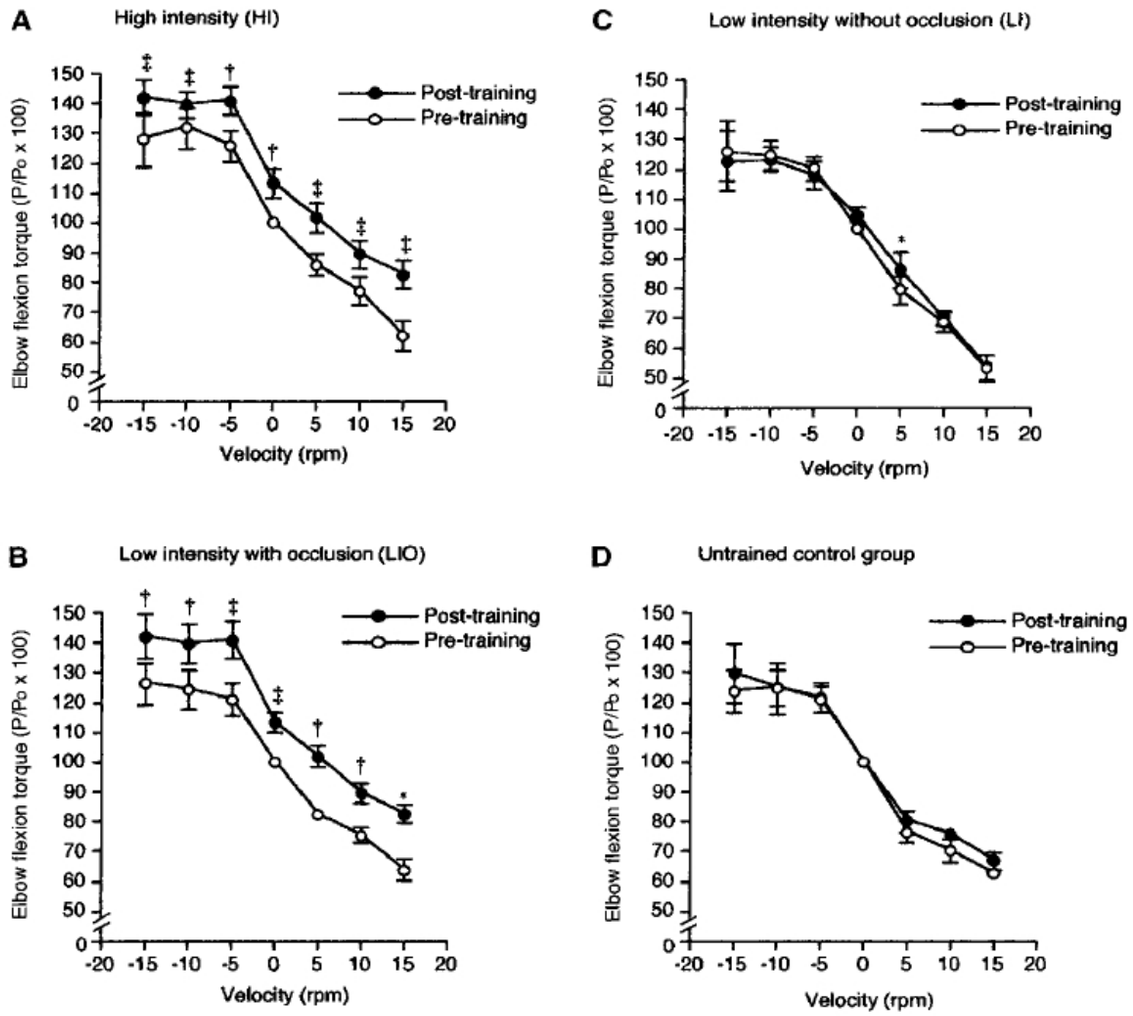
Importantly, it allows you to use very light weights (20-30% of your one rep max), which makes it suitable for the elderly and those who are already frail or recovering from an injury. The older you are, the more you need BFR. BFR is a game-changer to transform the health of our aging population, as it effectively improves cognitive decline and vascular function. By increasing nitric oxide, it improves the endothelial function of vessels. Also, the microcirculation (arterioles, venules, and capillaries) is increased in the elderly with BFR training. The risk of osteoporosis, fractures, falls and sarcopenia (age-related muscle loss) is reduced with BFR training. The treatment of strokes, cognitive decline and Alzheimer's has responded well to BFR training.

AEROBIC IMPROVEMENTS WITH BFR

Besides helping you grow bigger muscles, BFR training also improves your aerobic capacity and cardiovascular endurance. To understand the aerobic improvements,

you have to understand cardiac output. Cardiac output equals to stroke volume times the heart rate. Stroke volume is the volume of blood pumped out of the left ventricle per beat. The heart distributes blood through your arteries to the rest of the body and the veins return the blood back to the heart. During BFR, there is venous constriction which decreases the volume of blood returning to the heart. This reduces the stroke volume (amount of blood returning to the heart). In order to compensate for the decrease in stroke volume, there is a rapid increase in heart rate. This gives you the sensation of having to work very hard in order to do light loads.

One of the simplest ways to improve your aerobic capacity is to walk with the BFR bands high on your thigh for 15-20 minutes. Some authorities on BFR state that you can improve your aerobic capacity in just a few weeks of training. It is well known that walking in general does not activate the type 2 muscle fibers which are required to increase muscle mass. In contrast, walking with BFR bands has been proven to result in hypertrophy (enlargement) of the thigh and increased strength at the knee. Effectiveness of BFR is shown in charts below.

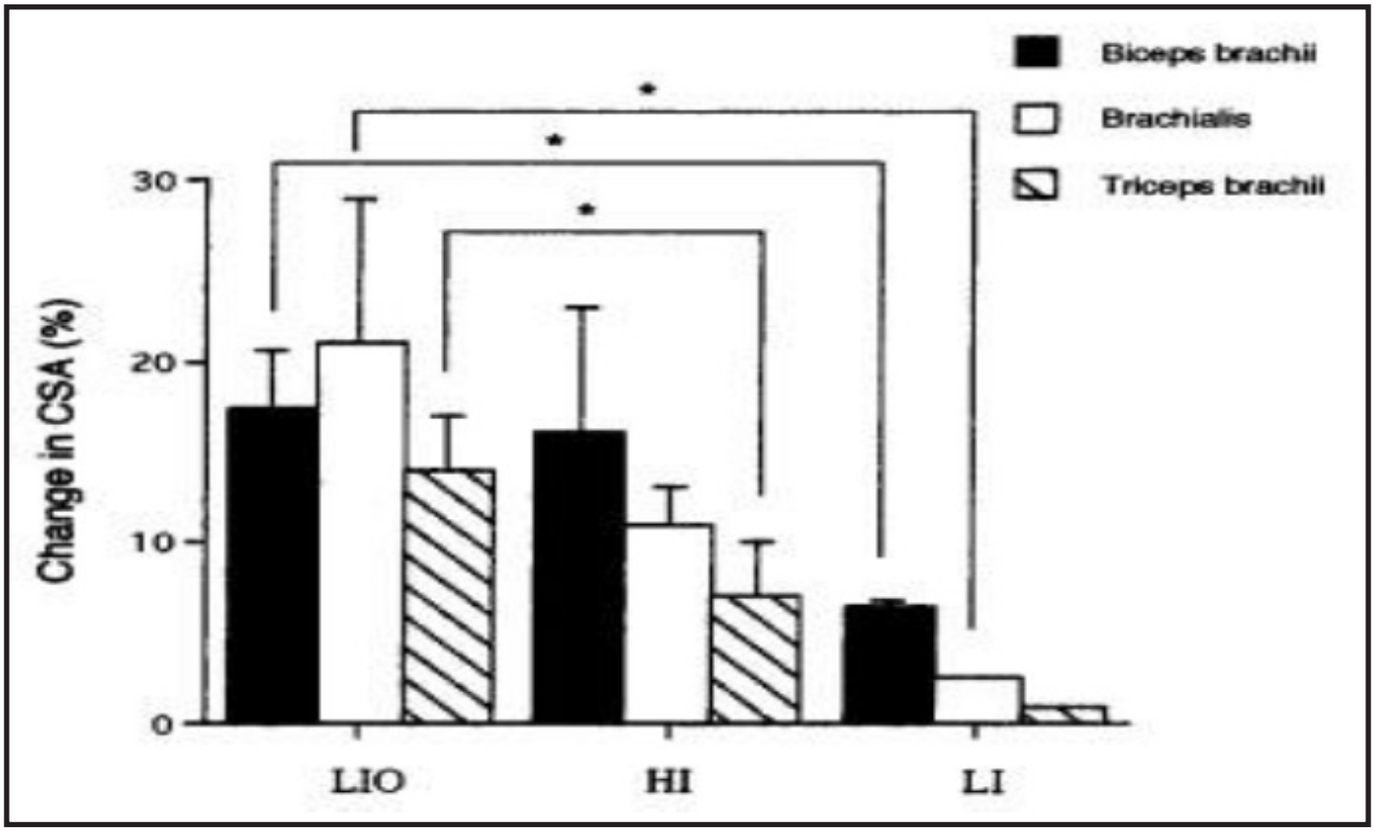


THE EFFECTIVENESS OF BFR STRENGTH

In 2000, The Journal of Applied Physiology compared high intensity training to low intensity training with BFR and to low intensity training without BFR. The study (At bottom of previous page) showed that low intensity training with BFR showed the same strength gains as the traditional high intensity training. The group with low intensity training without BFR showed no strength gains.

CROSS SECTIONAL AREA (Increased size or hypertrophy)

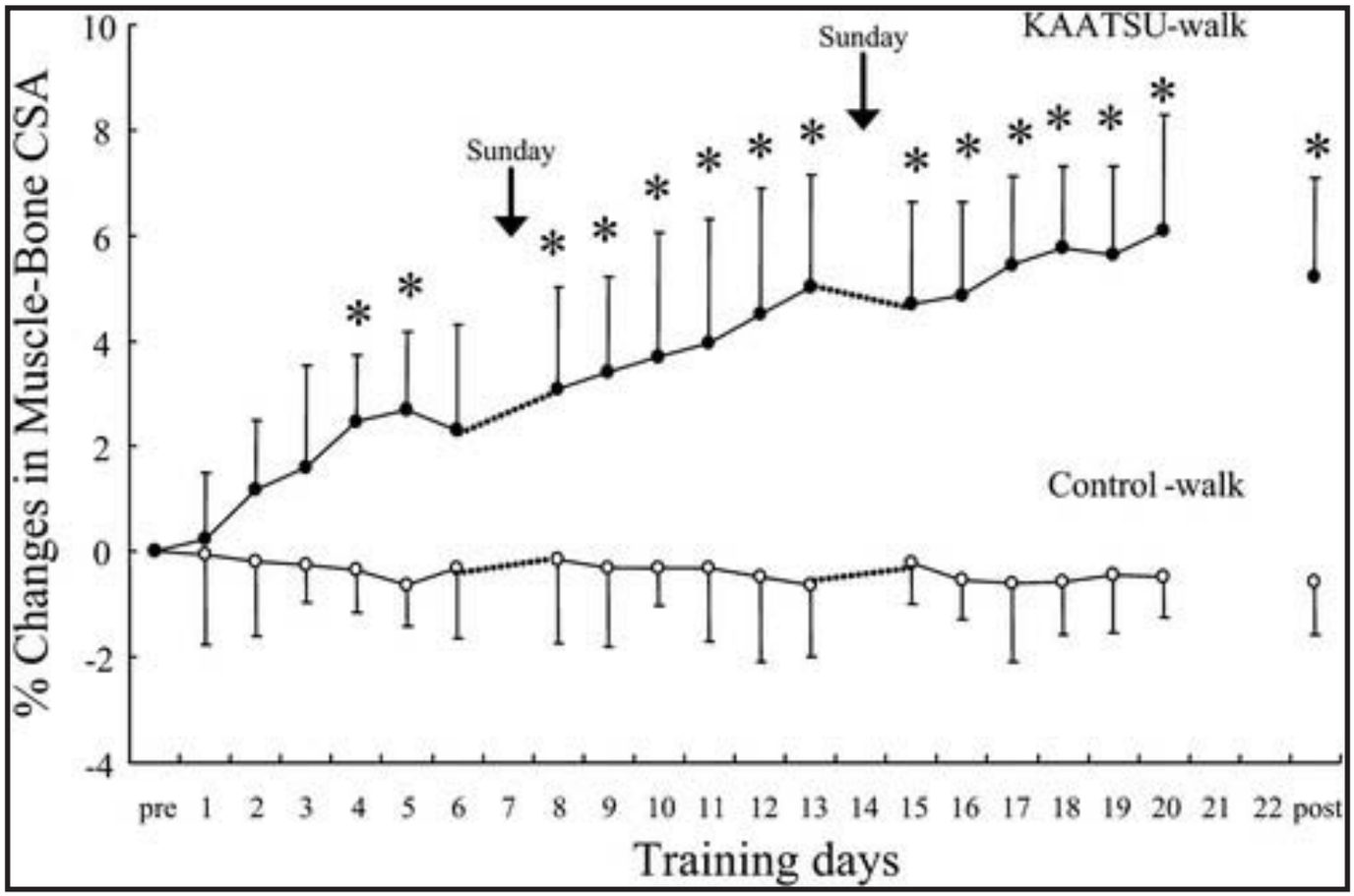
The above same study also looked at the percentage changes in the cross sectional area of biceps, brachialis and triceps muscle after exercise training. The low intensity group with BFR showed a greater response of the muscle groups when compared to high intensity group. The low intensity group without BFR showed no benefit. This proved that low intensity BFR can produce an increase in size or hypertrophy comparable to high intensity training.



CROSS SECTIONAL AREA (Hypertrophy) with WALKING

In 2006, Dr. Soto did a study comparing walking using BFR to walking without BFR. The BFR group showed a marked increase in cross sectional area (hypertro-

phy) of the muscles. Traditional walking without BFR showed no increase in hypertrophy of the muscles.



CROSS SECTIONAL AREA—WALKING

INCREASE STRENGTH AND SIZE WITH WALKING AND BFR

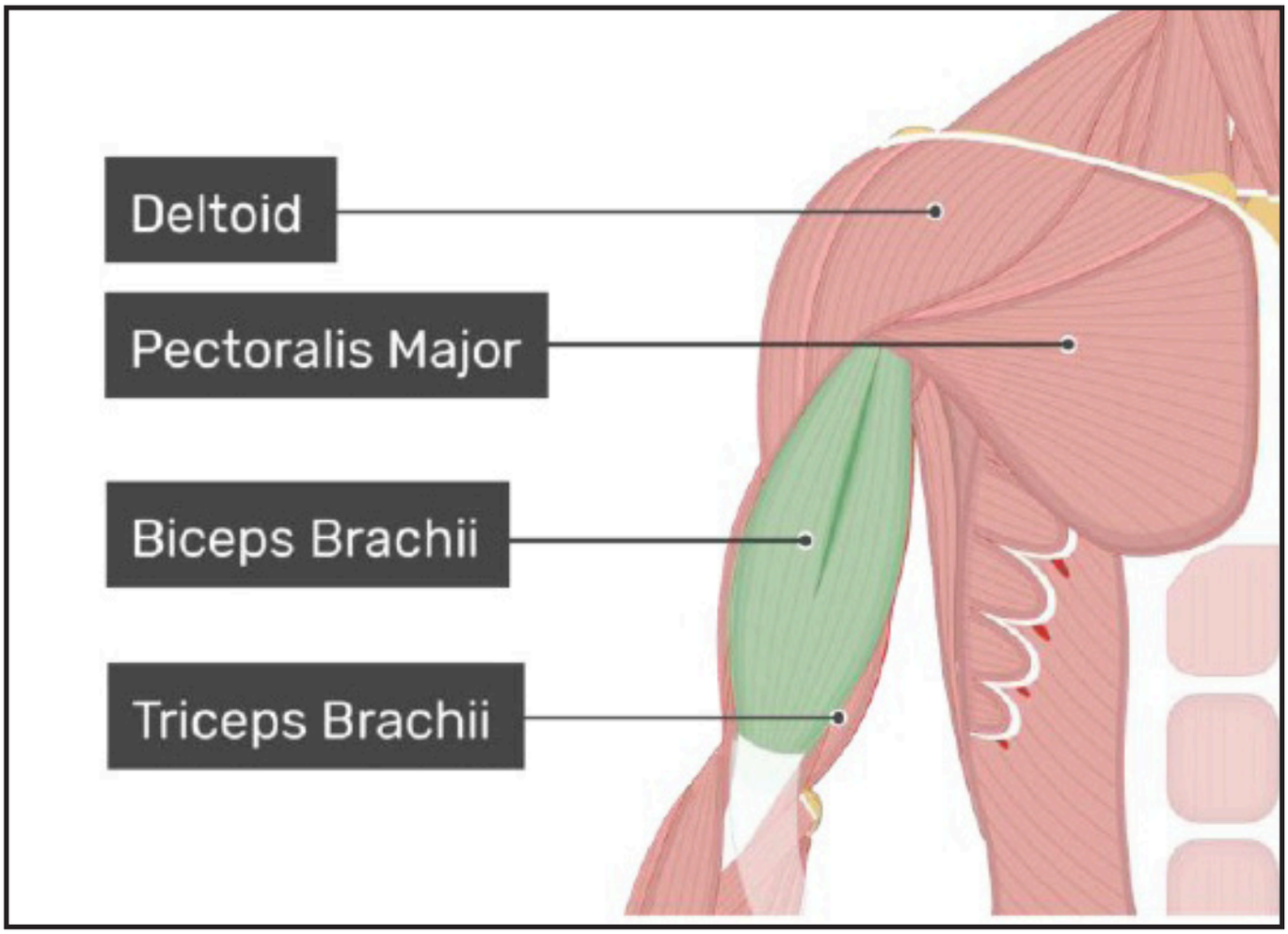
One study showed the percentage changes in strength (leg press), muscle cross sectional area, and blood hormone changes after walking for 3 weeks. They only walked for 10 minutes twice a day for 3 weeks. Their speed for walking was only 2 miles per hour which is a slow walking speed. The normal speed for the first stage of Bruce Protocol is 3 miles per hour. Their leg press was stronger and size of their thigh muscle was much larger. Their bone density was better and the IGF-1 was increased suggesting increased muscle protein synthesis.

CROSS SECTIONAL AREA AND STRENGTH (Proximal and Distal)

The study showed increased size in the triceps and pectoralis major using BFR training. The control group without BFR showed no benefit. The bench press

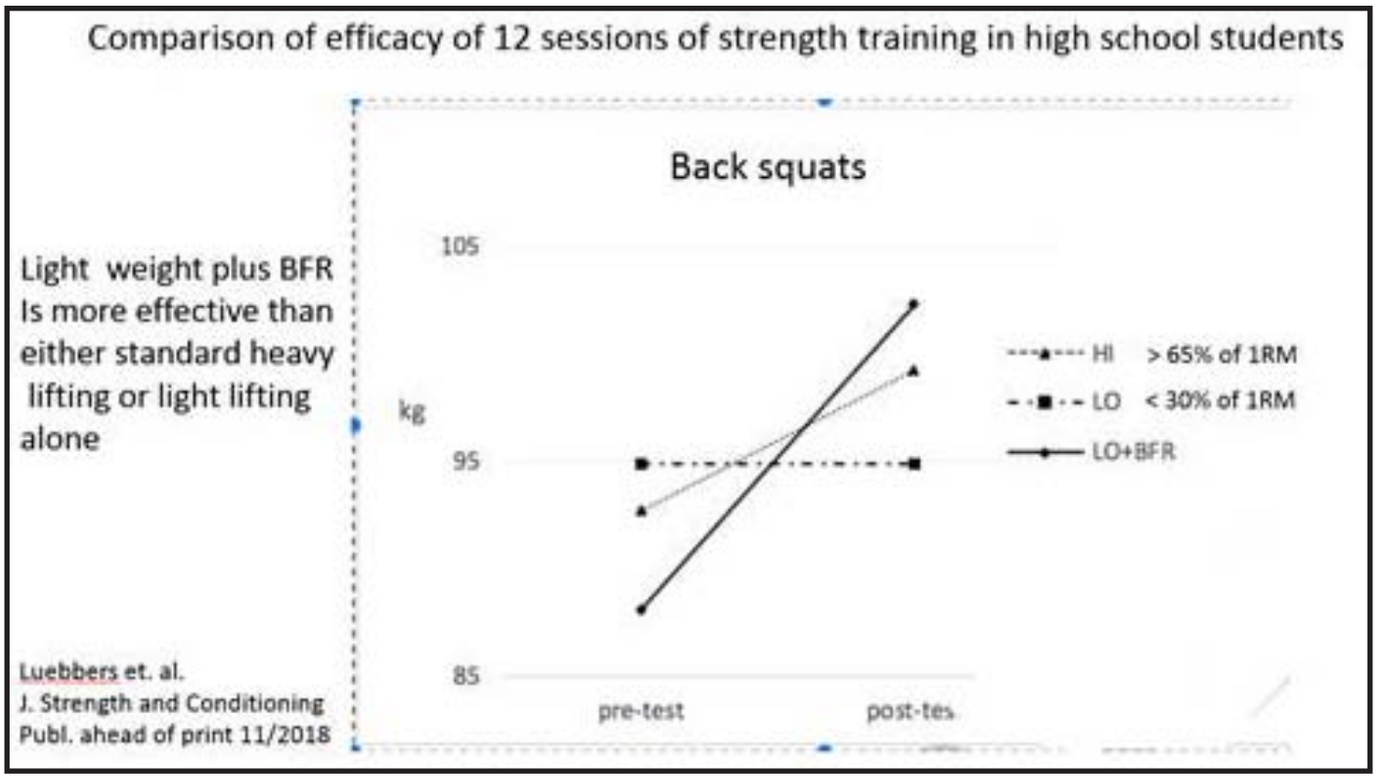
without BFR training showed no benefit in strength. This shows that when a muscle like the biceps becomes fatigued, your body will recruit other muscles like the pectoralis major to help complete the exercise. The mechanical tension creates muscle recruitment from other nearby muscles.

When you are working the biceps muscle, there will be growth in other muscles like the pectoralis major from the systemic effects of BFR training. This is due to production of anabolic hormones like growth hormone and IGF-1. Also, the mechanical tension creates muscle recruitment from other nearby muscles.



STRENGTH - SQUATS

A study was performed with high school weight lifters for 6 weeks to see which exercise would result in the strongest strength gains doing a 1-rep maximum squat. There were three groups (low intensity without BFR, low intensity with BFR and high intensity using heavy weights. The low intensity with BFR had the strongest strength gains for a 1-rep max squat at the completion of six weeks of training.



BFR AND PAIN REDUCTION

Exercise can increase endorphins which are involved in pain reduction and mood. Short term anaerobic exercise leads to an increase in endorphin levels. This increase is also correlated to an increase in lactate concentration. Endurance exercise like running does not increase endorphins unless you have been running for over an hour.

BFR AND OSTEOARTHRITIS

A study in 2019 showed that BFR training and high-intensity training were both effective in increasing muscle strength, quadriceps muscle mass and functionality in patients with osteoarthritis of knees. BFR was able to improve pain more than high intensive therapy, while inducing less joint stress. This was felt to be an effective treatment for osteoarthritis patients.

BFR AND SPRINTING

In 2016, a study for 6 weeks was performed comparing BFR to traditional sprinting of a 100 meter dash. The BFR group would run 6 times (60-70% of their maximum speed) when compared to a control group without BFR. The BFR group had a

faster speed and showed more growth on the thigh, when compared to the control group. A measure of strength called rate force development was better in the BFR group. The BFR training showed better size, strength and speed.

BFR AND ATTENUATION OF ATROPHY

In 2008, a study was performed on healthy males who were immobilized in a cast for 2 weeks. There were three groups in the study (a BFR group, a group doing isometric exercise, and a group doing no exercise). Only the BFR group was able to prevent atrophy when the casts were removed.

HOW TO UTILIZE FATIGUE WITH BFR TRAINING

Fatigue is important to create muscle hypertrophy and strength. The points below emphasize what we are looking for in typical "ideal" fatigue.

1. The first set of repetitions is completed easily
2. The second set produces some muscle burn, but you are able to complete all repetitions.
3. The third set starts with discomfort and you may not be able to complete all repetitions. A strong muscle burn will be present in third set
4. The frequency of reps slows down and your form breaks down.
5. There is increase in breathing, sweating and heart rate.

IS BLOOD FLOW RESTRICTION SAFE?

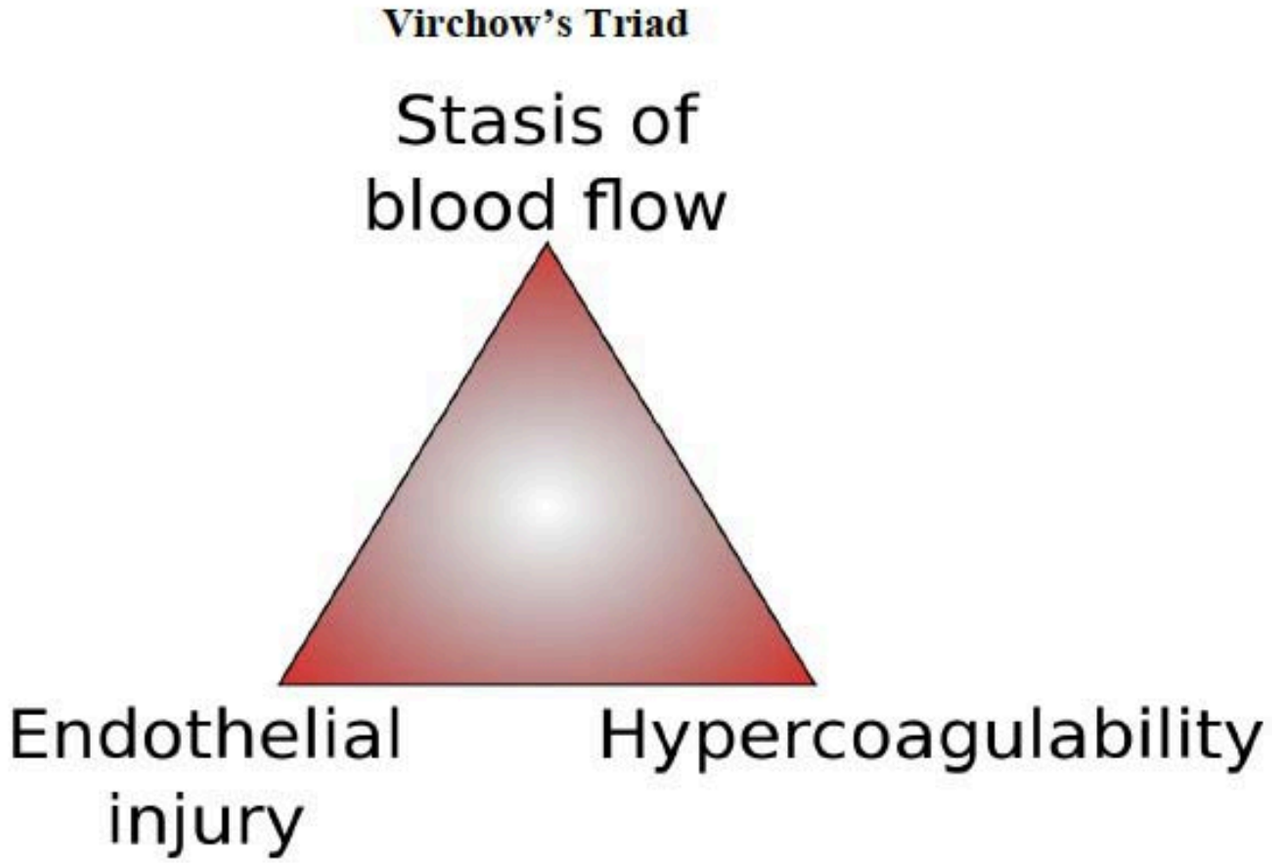
In 2006 and 2016, national surveys were performed to investigate the risks of BFR training in Japan. Over 100 facilities were analyzed with 12,642 individuals who were doing various types of exercise with BFR training, which included traditional physical exercise, walking, cycling and weight training. The age range was from teenagers to greater than 80 years of age. The rate of major complications listed below was lower than occurs in the normal population in people not doing BFR training.

1. Venous thrombosis – (0.055%)
2. Pulmonary embolism – (0.008%)
3. Rhabdomyolysis – (0.008%)

WHICH THREE THINGS MAKE BFR SAFE?

1. Never causing stasis or stopping the flow of blood
2. Allowing movement of working limb through its available ranges
3. Monitoring for perceptions of pain and numbness while doing BFR

A lot of people are concerned about the risk of deep venous thrombosis and pulmonary embolus when there is blood flow restriction of a limb. The risk of thrombosis is related to Virchow's triad, which includes stasis of blood flow, endothelial injury, and hypercoagulabilty. Stasis of blood flow does not occur with BFR, because the arterial inflow is maintained during exercise. Unlike surgery, BFR does not cause endothelial injury. BFR can increase nitric oxide and vascular endothelial growth factor which improves the function of the endothelium and can even increase the microcirculation which will improve blood flow to the muscle. Hypercoagulability can occur in individuals with blood clotting disorders like Factor V Leiden which can cause spontaneous thrombosis not related to BFR. This is the reason it is important to obtain a good history to rule out blood clotting disorders in individuals considering BFR training.



CONTRAINDICATIONS FOR BFR TRAINING

1. Pregnancy
2. Sickle cell anemia
3. Untreated DVT
4. Active cancer on cancer medications
5. Indwelling dialysis catheters of vascular access ports
6. Recent skin or vascular grafts
7. Active Lymphedema in limb

PRECAUTIONS FOR BFR TRAINING

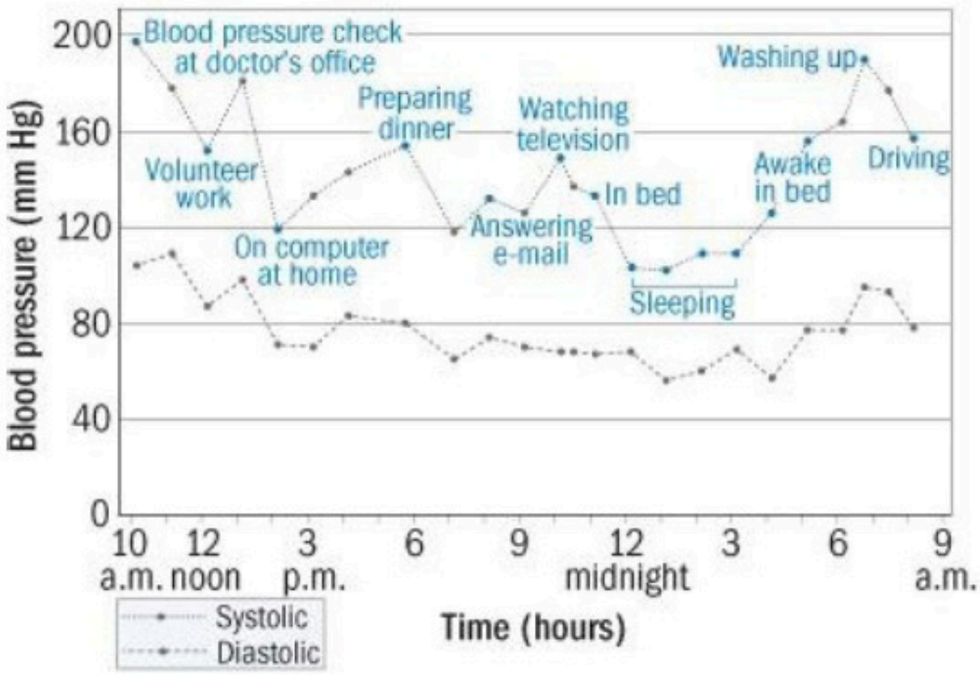
1. Cardiac disease
2. Peripheral Vascular Disease
3. Peripheral Neuropathy
4. Varicose Veins
5. Increased Intracranial Pressure
6. Less than 2 weeks post-operative
7. Limited exercise experience
8. Atrial Fibrillation and anticoagulation
9. Reports of pain
10. Multiple Comorbidities

WHAT ABOUT RISKS OF BLOOD PRESSURE DURING BFR?

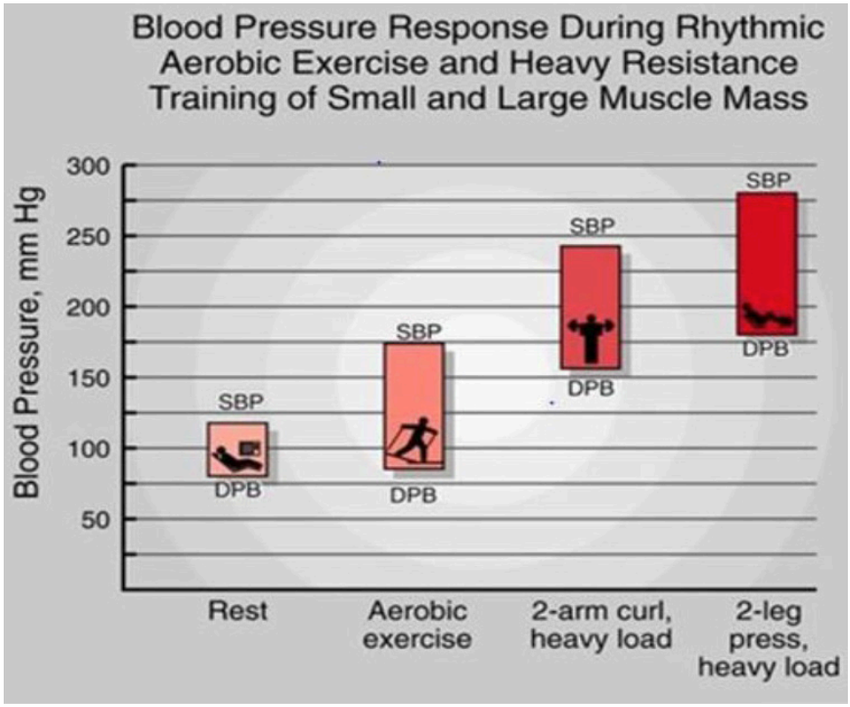
Blood pressure needs to be controlled at rest before proceeding with BFR training. Normally, blood pressure will increase from rest to exercise. BFR and regular exercise have both been shown to decrease resting blood pressure. This illustrates that exercise is good for your blood pressure and may reduce your need for hypertensive medications.

It is known that in power lifters and during high intensity exercise, blood pressure can increase to over 400 systolic and over 300 diastolic blood pressure. During intense cycling and marathon running, blood pressure can generate a systolic greater than 250 and diastolic greater than 150.

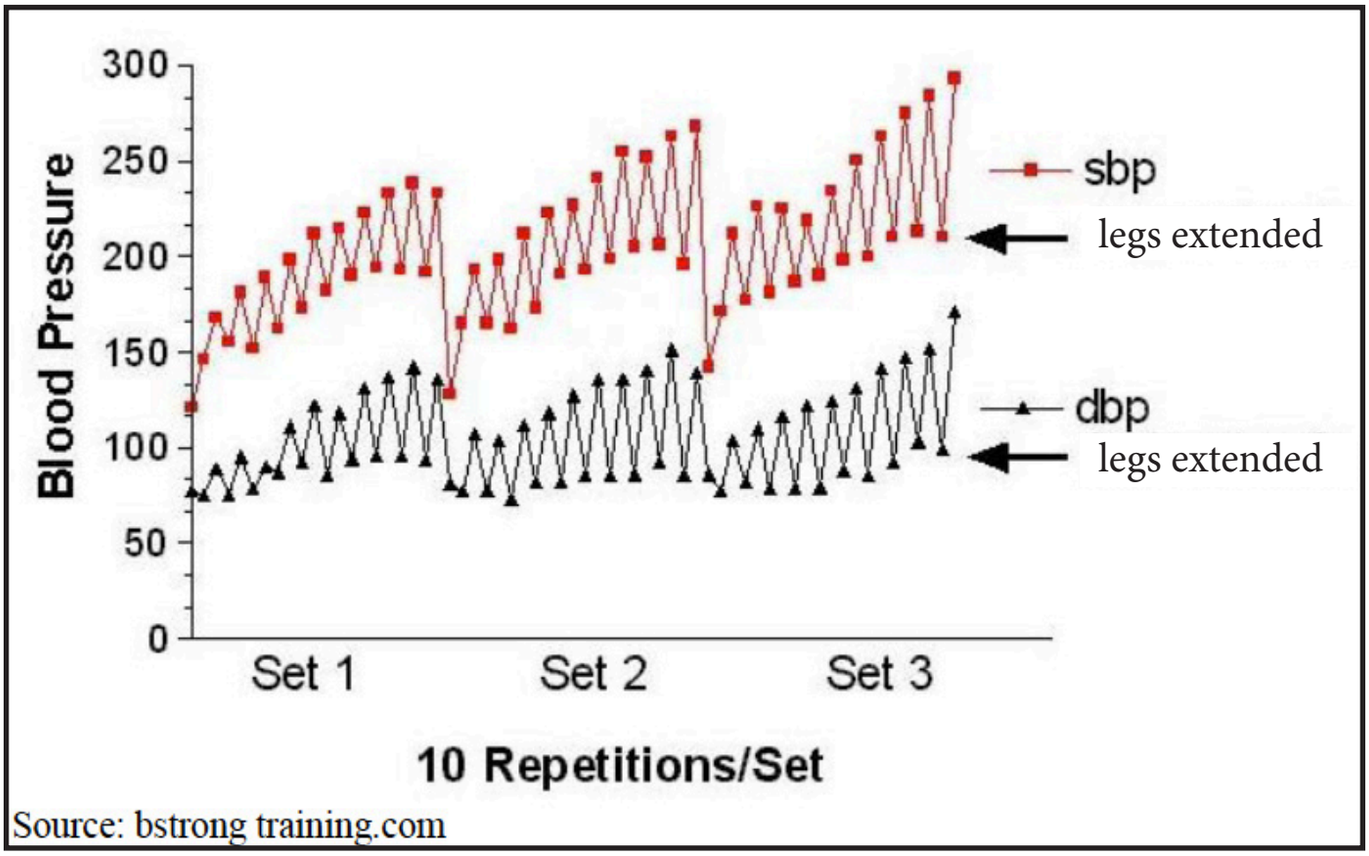
Blood pressure usually varies throughout the day depending upon your activity, stress and diet. The graph below shows the flucuations throughout the day.
Normally, blood pressure increases when going from rest to exercise. A greater rise in blood pressure occurs when the exercise goes from aerobic to heavy resistance as shown in graph below.



Source: bstrong. training.com



The graph on the left shows how blood pressure can be normal at rest and increase to very high levels with exercise (systolic BP nearly 300 and diastolic BP of 150). This increase to dangerous levels only occurs for a short period during a 24 hour period. Very rarely, exercise can cause a heart attack or stroke. It is the consensus of physicians that the benefits from regular exercise outweigh the risk of a sudden heart attack or stroke.



Source: bstrong training.com

The good news is that individuals doing BFR exercises have lower blood pressure than individuals performing high resistant exercises like squats. Also, BFR improves blood pressure due to increased production of nitric oxide which increases in the microcirculation and improvement in endothelial function.

In summary, blood pressure needs to be controlled at rest prior to considering BFR training. Patients with hypertension need to avoid doing BFR with rigid, non-elastic bands or blood pressure cuffs. These are more likely to result in dangerous elevation of your blood pressure.

PERIPHERAL NEUROPATHY AND BFR

Neuropathy can be caused by occlusion of small vessels and interruption of axonal flow to the nerve. This causes local ischemia and eventually leads to focal demyelination over time. Anyone who has ever crossed their legs, can cause pressure on the nerve and result in numbness and pain. Just like BFR, you can uncross your legs and the sensation of numbness resolves and goes back to normal.

Any cuff or band, if pressure is high enough (occlusive), can cause ischemic damage to the small vessels in the peripheral nerves resulting in neuropathy.

Very narrow, non-elastic, non-pneumatic, rigid belts which are placed too tightly, can pin a nerve against a bone and cause direct mechanical compression. The incidence of peripheral nerve compression is low (< 2%) and most cases are transient in nature. The incidence is more common if the site of pressure is near the knee rather than in the upper leg near the groin.

WHAT ABOUT MUSCLE DAMAGE (RHABDOMYOLYSIS) USING BFR?

The available evidence suggests that minimal to no muscle damage is occurring with BFR training. If muscle damage occurs, it is called rhabdomyolysis and can occur with intense muscle strain, crush trauma, electrocution and drug use. Rhabdomyolysis is a disease caused by the rapid breakdown of muscle tissue released into the bloodstream. Myoglobin, a component protein of skeletal muscle tissue, in large amounts, can cause renal failure by accumulating in the kidneys and preventing proper function of that organ. Patients who develop rhabdomyolysis often feel extreme pain in the area of muscle damage and display dark and concentrated urine with weakness and fatigue. An elevated creatinine phosphokinase (CPK) helps to confirm the diagnosis. Rhabdomyolysis should be suspected with intense muscular pain while doing BFR and confirmed with serum CPK and urine myoglobin.

WHAT ABOUT RISKS OF BFR IN PATIENTS WITH ISCHEMIC HEART DISEASE?

A study in 2012 was performed on patients with ischemic heart disease who were exercised and an inflammatory marker such as C-reactive protein was measured. The results showed there was no exercise induced elevation of inflammatory markers in patients with stable ischemic heart disease.

WHAT ABOUT RISKS OF BFR IN PATIENTS WITH CHF?

A study involving chronic heart failure patients showed that BFR training increased their aerobic capacity and decreased their BNP (brain natriuretic peptide). The BNP level is elevated when pressure builds up inside your heart from volume overload. The higher the BNP number, the more likely heart failure is present and the more severe it is. Blood flow restrictive training can decrease the systemic vascular resistance and central venous pressure and improve congestive heart failure.

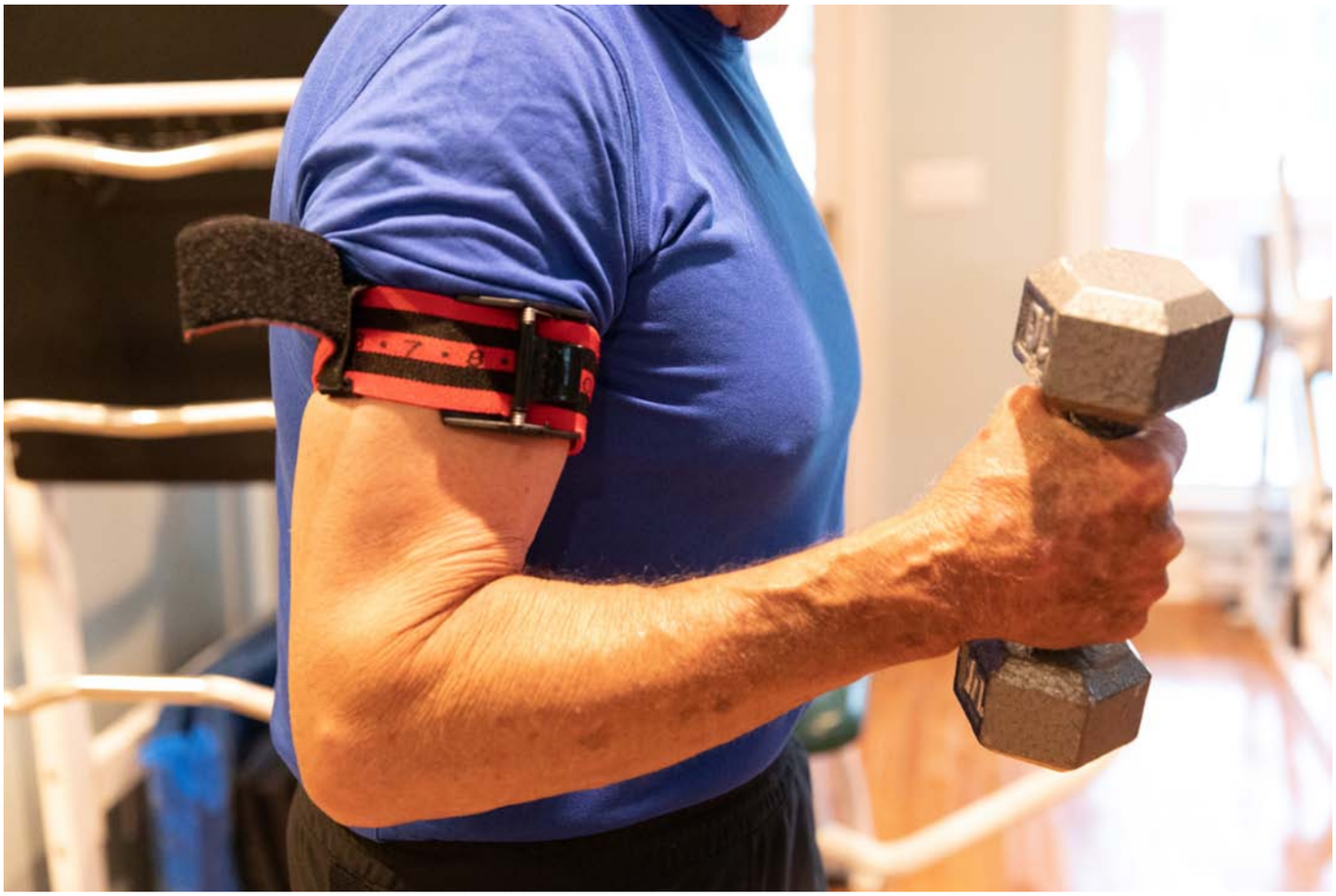
SAFE PLACEMENT OF CUFFS

There are only two places a blood flow restriction device should be placed:

1. Upper Arm (In picture below)
2. Upper Thigh (Picture next page)

For the upper arm, the cuff should be placed very close to your arm pit, just where your biceps muscle begins and the deltoid muscle ends. On your legs, you can apply them right below your hips at top of quads, close to your groin.

Incorrect placement can prevent optimal blood flow restriction and disallow the hormonal effects and muscle growth. Do not put bands over your knees or elbows which could cause nerve injuries due to superficial position of the neurovascular bundle.



Arterial Occlusion Pressure

The BFR bands need to be tight enough to restrict blood flow in the exercising muscles. This lowers the oxygen levels in the muscles which stimulates anabolic

Correct placement on legs

hormone production and subsequent muscle growth. Arterial occlusion pressure (AOP) is the pressure needed to restrict 100% of blood that is supplying a limb. AOP is a dangerous scenario and must be avoided at all cost. This can lead to arterial thrombosis, deep venous thrombosis and pulmonary embolus.

Recent research has shown that the pressure needs to be 40% of the arterial occlusion pressure for BFR to have a beneficial effect. Also, it was determined that if pressures exceed 60% of the AOP there is no benefit and can be associated with increased risk of injury. The most frequently applied method to determine the aortic occlusion pressure is the Doppler ultrasound technique. However, despite its high accuracy, the practicability of this gold-standard is limited, mainly owing to the costs of doing routine ultrasound on everyone doing BFR. Also, studies have shown tremendous variability in the aortic occlusion pressure when measured on a day to day basis. This would suggest that you need a daily AOP to be entirely safe with performing BFR.

We feel that BFR can be safely performed without doing a Doppler ultrasound technique to measure the aortic occlusion pressure. This requires that prior to each individual participating in BFR, they must be seen by a physician to determine if it

is safe for them to exercise and participate in BFR. The physician will do a complete evaluation to include the following things:

1. A detailed history to make sure there is no contraindications to performing BFR such as uncontrolled blood pressure, active congestive heart failure, ongoing chest pain, deep venous thrombosis, pulmonary embolus, active infection, severe COPD, peripheral vascular disease or hypercoagulability (blood clotting disorders).
2. A detailed exam with measuring blood pressure in both arms and checking pulses in both arms and feet. If any abnormalities are found, an Ankle-Brachial index needs to be measured. This is an inexpensive test that can be completed within 5 minutes.

The Importance of Good Physical Examination with BFR

After physician approval, individuals performing BFR need to self-monitor for the following symptoms and exam findings:

1. If you get pain or numbness, you must loosen the bands immediately.
2. You must monitor your capillary refill time to make sure that you are getting enough blood flow to the exercising muscle. This is determined by pressing your index finger firmly into the palm of your hand under your thumb, then quickly releasing and seeing how long the white blanched area takes to turn pink. If it takes longer than three seconds, the bands are too tight. You can also check the capillary refill time on the tissue right above your knee, after the bands have been tightened. It should not be greater than three seconds.
3. Your veins will become distended when the bands are tightened (popping out a bit). They should not feel uncomfortable and the skin should not have a bluish or gray tone. If the skin becomes bluish or gray, there is restriction of arterial flow and the bands need to be loosened.
4. It is important to realize that your arms will swell during the exercise, which will cause the bands to tighten. A simple way to determine accurate pressure tightness is the finger test underneath the band. You want the bands tight enough, that you cannot get two fingers under the band, but loose enough that you can squeeze one finger under the band.
5. Another confirming factor that the bands are tight enough is to measure the circumference of your limb before and after exercise. You should notice an in-

crease of at least one-half inch to one inch after your exercise.
6. **WARNING**! To avoid any muscle damage, the bands should be only left on the arms for 15 minutes at a time and only 20 minutes at a time for your legs.
7. Only put the bands on the extremities that you are exercising and remove them before moving on to the next area. In other words, you cannot perform BFR on the legs and arms at the same time. This could decrease your blood pressure and cause you to pass out.
8. **STOP BFR** and loosen bands if you have sensation of numbness, pain, light headiness or dizziness.

FINDING YOUR IDEAL LEVEL OF RESISTANCE

BFR is the perfect exercise for all ages. Instead of using heavy weights that can increase your risk of injury during conventional weight training, BFR allows you to use 20-30% of the resistance used in conventional resistance training. This 20-30% number is derived from your 1 rep max (1RM). For example, if your maximum weight for a biceps curl is 25 pounds, you would select a five-pound dumbbell (20% of your 1 rep max) to start the exercise. By starting at a lighter weight, it will give your body a chance to adjust to BFR and avoid potential injuries. An additional benefit is that if you start with lighter weights, you can train more frequently, because you won't cause as much muscle damage.

If you don't know your 1 rep max, then all you have to do is pick a weight you believe you can easily do 30 reps on your first set and start there. Conversely, if you are unable to complete 20 reps on your first set, the resistance is likely too high and needs to be decreased. Also, the ability to do all of your sets at the same weight indicates that you need to increase the resistance to get good results.

EFFECTIVENESS OF BFR REQUIRES A STRONG EFFORT

The most important principle for successful BFR is your level of intensity. Muscle growth and strength is highly dependent upon the production of anabolic hormones, which requires you to push your sets to failure to achieve this. Pushing to failure creates a metabolic crisis in your muscles, which causes fat burning, strength and muscular hypertrophy. The following signs indicate that you have given a good effort:

1. You are sweating a lot.
2. Your heart rate and breathing are increased, which indicates that you have activated your sympathetic nervous system by firing your type 2 muscle fibers.
3. You should notice an enlargement of the circumference of your limb of at least ½ inch or more after exercise.
4. Another great indication is when you are unable to do all of your reps on the third and fourth sets. This suggests muscle failure. Muscle failure means that you are unable to do another rep if your life depended upon it.

BEST PRACTICES AND PROTOCOLS WITH BFR

A. START SLOW WITH BFR

It is so important that you start slowly and work your way up over time. This is especially important if you are elderly or sedentary. A lot of participants with BFR may choose to just use their own body weight and not use any weights. This is a good starting point, which can be followed by light dumbbells. BFR can be done without machines in the convenience of your home. Walking with the bands on can increase thigh muscle size and strength in both the young and elderly adult. Also, walking with BFR bands can improve cardiac autonomic control by improving your heart rate variability. A lot of people doing BFR will develop hypertrophy and strength in only 4-6 weeks. We have seen incredible gains in just 2 weeks in some more fit individuals.

B. NUMBER OF REPETITIONS IN EACH SET

FIRST SET	30 reps	30 seconds of rest
SECOND SET	15 reps	30 seconds of rest
THIRD SET	15 reps	30 seconds of rest
FOURTH SET	15 reps	30 seconds of rest

C. BFR BAND DURATION AND REST PERIODS

An important point is to not loosen your BFR bands until after 15 minutes of exercise for your arms and 20 minutes on your legs. This will improve your results with BFR training. We can obtain 3 different exercises in this 15-minute period, before removing the BFR bands. There is a rest period of 1 minute between each exercise and a rest period of 2 minutes after each 15 minutes of exercise.

D. TRAINING FREQUENCY

One of the major advantages of BFR training is that it causes far less muscle damage when compared to high load resistance training. This allows you to train more frequently. The frequency of training needs to be individualized as it varies widely. It can vary from as little as twice per week, up to three times a day, depending on your goals and fitness level. A study in elderly patients showed that doing BFR training twice per week was enough to maintain gains. When training decreased to once per week, the gains failed to be maintained.

E. DIFFERENT BAND OPTIONS FOR DOING BFR

The KAATSU machine was designed by Dr. Soto, who is considered the "father of BFR training". The master unit is expensive and can cost as much as $6,000, while the newest consumer version is available at $899. The major advantage of this machine is it can do cycle compressions, consisting of compression of limb for 30 seconds and then relaxing for 5 seconds. Over the course of 8 rounds of compressions, the device will progressively increase the pressure for each cycle. The pressure can also be easily adjusted from very low to high. If you can afford it, the KAATSU system is a lot easier to dial in the correct pressure.

Strong BFR Bands like KAATSU are able to control the pressure well and also have less risk of injury. The bands are inflated to individualized pressures which are prescribed by their proprietary system. The inventor of this system is Dr. Jim Stray-Gundersen who is an Olympic coach and strength trainer. The cost of this system is about $200 to $300.

We like the BFR Bands PRO X Model which only costs about $15. It does not have a pressurized system like KAATSU or B Strong BFR Bands. The easy pull to tighten buckle works great for a one-handed operation. You simply pull to tighten and gently lift the lever to release the band. The PRO X Bands come with a patent pending pressure tracking system so you can train with symmetry and precision. A numbered increment on each occlusion cuff allows you to ensure you are achieving equal pressure on both arms. This system requires that you check your pulses and capillary refill between sets to ensure that you are not compromising arterial inflow.

F. CORRECT BREATHING DURING BFR TRAINING

Knowing how to breathe is essential in order to be successful with BFR training. Many people will do this backward and inhale when they exert. They are afraid that the weight is going to fall on them, so they hold their breath when straining to lift the weight. Holding your breath when you lift creates a Valsalva maneuver (increased pressure inside your chest), which may:

1. Reduce blood flow to your heart
2. Reduce blood flow to your brain
3. Cause you to be dizzy and pass out
4. Increase your risk of hernia

The way to remember how to breathe is to always breathe out with effort. For example, if you are doing a bench press, take a breath in as you lower the weight, and breathe out as you push the weight up.

BFR TRAINING PROTOCOL

Training to exhaustion is one of the secrets to BFR training that increases your fat burning and muscle building hormones. This causes all of the muscle fibers to be recruited to participate in muscle contraction. This can be accomplished with light weights at any age. For beginners and senior citizens we encourage only working out 3 days a week.

BFR Training for Beginners and Senior Citizens

For many older adults, growing older seems to involve an inevitable loss of strength, energy, and vigor. But it need not be so. The frailty and decreased energy we associate with aging, such as difficulty walking for distances, climbing stairs, or carrying groceries, are largely due to muscle loss (sarcopenia). This muscle loss results mainly from inactivity. The old saying is true when it comes to muscle: "Use it or lose it."

One of the best ways to keep muscles healthy and strong is through exercises called strength training—sometimes known as weight lifting or resistance training. The problem is that elderly individuals cannot lift heavy weights which are required to

increase muscle size. With BFR, this can be accomplished with light weights and less risk of injury. BFR training can reduce the signs and symptoms of many diseases and chronic conditions in the following ways:

1. Arthritis – Reduces pain and stiffness, and increases strength and flexibility
2. Diabetes – Improves blood sugar control
3. Osteoporosis – Builds bone density and reduces risks for falls
4. Heart disease – Reduces cardiovascular risk by improving lipid profile and overall fitness
5. Obesity – Increases metabolism, which helps burn more calories and helps with long-term weight control.
6. Back pain – Strengthens back and abdominal muscles to reduce stress on the spine
7. Mental and Emotional Health – Improvement in depression and self-esteem
8. Better Sleep

BFR CAN PREVENT MUSCLE LOSS (SARCOPENIA)

You can get stronger and healthier as you age. This requires that you prevent sarcopenia, which is age related muscle loss. Many of us don't realize that skeletal muscle not only manages physical activity, but also plays a major role in metabolism, circulation and cognition. It is now known that skeletal muscle functions as an endocrine organ by secreting special cytokines (myokines) which regulates the function of other organs.

Skeletal muscle is the most abundant tissue and comprises 40% of your body mass. It is the primary storage tank of insulin mediated glucose disposal. After meals, 80% of your glucose is deposited in your skeletal muscle. It is also the main energy consumer of fat. The loss of muscle mass with advancing age is thought to be one of the major causes of insulin resistance in older adults.
Sarcopenia causes the loss of resilience and is a major factor in the ability to recover from illness. It is clear that the elderly with sarcopenia are more likely to suffer the following things:

1. Higher rates of complications and infections following surgery
2. Higher mortality from pneumonia
3. Contributes to immunosenescence, the gradual deterioration of your immune system, which is a leading cause of death in elderly.

4. Longer hospital stay, decreased functional decline at discharge, lowered quality of life and worse long term mortality.

There are many ways to increase your muscle mass but they mostly involve moving heavy weights. The problem with this strategy is that if you are not in good shape, and especially if you are elderly, there is a very high likelihood that you will get injured. In most cases, it is not if you will get injured but when.

The answer to this problem is an exercise strategy known as blood flow restriction training or BFR. As the name implies, BFR involves modifying the arterial inflow and venous outflow while you're working the muscle by placing an inflatable band around the extremity. Using very light weights, and in about 15 to 20 minutes, you get an exhaustive workout that sends a signal to your brain that says, "Hey, I've done something really hard here — you had better help me recover and adapt to it."

Your brain then sends out hormonal responses that cause your muscles and blood vessels to grow. Most would think that such light weights would be insufficient to provide any muscle strength improvements, but studies show an increase in muscle strength after only 12 weeks.

The BFR program outlined for beginners and senior citizens requires that you start slowly in the first two phases:

1. Strengthen your body slowly and gently using only your own body weight (Part 1)
2. After you can handle the exercises well with your own body weight, then you can begin using dumbbells and ankle weights (Part 2).
3. The final phase we called the advanced phase where you are using machines and more complicated exercises (Part 3).

The exercises are designed to strengthen all of the major muscle groups in the upper body (shoulders, upper arms, back, chest, and abdomen) and in the lower body (hips, thighs, knees, lower legs, and ankles). They also target muscles affected by osteoarthritis, particularly in the shoulders, hands, hips, and knees. Make sure that you are doing each exercise safely and properly with the full range of motion. Also, make sure that you breathe regularly throughout the exercises—don't hold your breath!

PART 1 – GETTING STARTED EXERCISES

This first part of your exercise program starts you on your journey to greater strength, balance, and coordination. This part is gentle and requires no special equipment so it can serve as an anchor program. You only need a chair and a wall. It's helpful (but not necessary) to have a mirror so you can check your form during the exercises. There are four exercises for the getting started exercises as shown below:

5- MINUTE WALK

Walk for 5 minutes to get your muscles warm and loose for strength training. You can walk outside if weather permits, inside around the house or on a treadmill if you have one. You can also use an exercise bike, rowing machine or stair stepper. The BFR bands need to be placed on both legs in the proximal segment near your groin prior to starting this exercise. Walking will help direct blood flow to your muscles and get your body ready for exercise. Warming up is important for preventing injury.

SQUATS

The squat is considered a compound movement, meaning it works multiple muscle groups across multiple joints. The primary muscles involved are your quadriceps (the muscles in front of your thighs) and your glutes (your butt muscles). The lowering portion of the squat works the muscles in your hamstrings and your hip flexors. Squats also work the muscles around the knees, which helps to build strength and prevent injury. The core muscles such as the abdominals are

activated and reduce the risk of lower back pain. When done correctly, a squat is one of the most effective muscle-builders there is. It trains a lot of muscles, particularly big ones like your quadriceps, hamstrings and glutes, and burns more calories per rep than almost any other exercise. However, as we age this natural movement becomes difficult to perform correctly.

Toddlers do picture-perfect squats all the time. Ever watch a toddler drop to pick up a toy from the floor. A toddler keeps his weight on his heels. His lower back stays naturally arched. The tops of his thighs go parallel to the floor or lower. His torso remains upright. It's the perfect execution of the squat—and he doesn't even think twice about doing it.

The best way to start squats is to train your muscles to know the proper position of a squat. The best way to do this is with a chair. Practice standing in front of a stationary chair and slowly sitting back in the chair. The feet are a little bit wider than shoulder width with the toes slightly pointed outward. Put your arms out in front of you for balance. Next you must hinge your hips by moving backward before bending your knees. If you bend your knees first, they will move in front of your toes, which may cause some lower back injury. Trying to keep the back straight as you sit backward ensures a proper position.

WALL PUSHUPS

This exercise is a modified version of the push-up you may have done years ago in physical education classes. It is easier than a push-up and you don't need to get down on the floor—but it will help to strengthen your arms, shoulders, and chest. You can make this exercise easier or more challenging by adjusting the distance your feet are away from the wall. The farther away they are, the more of your own body weight you will have to support, and the harder the move will be.

1. Place your feet about shoulder-width apart, standing about 2 feet from a wall with your arms straight out in front of you
2. Bend your elbows and begin to lean your body toward the wall until your nose almost touches it (start of exercise).
3. Push back to the starting position with your arms straight out in front of you (finish of exercise).

TOE STANDS

If a walk in the park no longer seems easy or enjoyable, the toe stand exercise is for you! It will help make that stroll in the park fun and relaxing by strengthening your calves and ankles and restoring stability and balance.

1. Stand with your feet shoulder-width apart near a sturdy chair. Use the chair or counter for balance.

2. Slowly push up as far as you can onto the balls of your feet. Hold this position for 2 to 4 seconds.
3. Then slowly lower your heels back to the floor.
4. Do 15 toe stands for one set. Rest one minute and then do a second set of 15 reps.

Part 1 will be performed 3 days a week. The BFR bands will be placed on prior to beginning exercise and must be removed after 20 minutes of exercise. Do 15 reps for each set and then rest for one minute. Then complete a second set of 15 reps on each exercise. This routine should be followed for 6 weeks prior to proceeding to part 2.

1. Monday – 5 minute walk, Squats, Wall Pushups and Toe raises
2. Wednesday - 5 minute walk, Squats, Wall Pushups and Toe raises
3. Friday - 5 minute walk, Squats, Wall Pushups and Toe raises

Part 2 – Stepping Up Your Strength

This part of the program is more challenging because it adds weights to the exercises. When you start this part, approach the exercises enthusiastically but with care.

Dumbbell Curls

1. While sitting or standing, hold a dumbbell in each hand (start of exercise)
2. Bend your elbows, bringing the dumbbells up to your shoulders while keeping your elbows by your sides (finish of exercise)

Dumbbell Overhead Press

1. Either sitting or standing, hold a dumbbell in each hand
2. Move the dumbbells to shoulder height (starting position)
3. Raise your arms overhead as high as possible (finish of exercise)

Knee Extension

This exercise strengthens weak knees and reduces the symptoms of arthritis of the knee by targeting the muscles of the front of the thigh.

1. Put your ankle weights on snugly. Sit all the way back in a sturdy chair so that your feet barely touch the ground.
If your chair is too low, add a rolled-up towel under your knees.
2. Point your toes forward. Flex your left foot and slowly lift your right leg. Extend your leg until your knee is straight.
3. Then, slowly lower your foot back to the ground.
4. Repeat 15 times with each leg and rest for one-minute. Then do a second set of 15 reps with each leg

Knee Curl

This is an excellent exercise for strengthening the muscles of the back of the upper leg, known as the hamstrings. Walking and climbing are easier when you do both the knee extensions and knee curl.

1. Keep your ankle weights on and stand behind a sturdy chair. Your feet should be a little less than shoulder-width apart and face forward.
2. Keep your foot flexed and slowly bend your left leg and bring your heel up toward your buttocks.
3. Then, slowly lower your foot back to the ground.
4. Repeat 15 times on each leg and then rest for one minute followed by a second set of 15 reps with each leg.

Part 2 will be performed 3 days a week. The BFR bands will be placed on prior to beginning exercise and must be removed after 20 minutes of exercise. Do 15 reps for each set and then rest for one minute. Then complete a second set of 15 reps on each exercise. This routine should be followed for 6 weeks prior to proceeding to part 3.

1. Monday – Dumbbell curls, Dumbbell press, knee extension, knee curls
2. Wednesday – Dumbbell curls, Dumbbell press, Knee extension and knee curls
3. Friday – Dumbbell curls, Dumbbell press, Knee extension and Knee curls

Part 3 – Advanced BFR Workout

The advanced BFR program is for individuals who are experienced in doing strength training. This protocol does a 5 day routine of heavy load resistant training alternating with low load (30% of your 1 rep max) BFR training. The heavy load program has different rest periods and does a lower number of reps when compared to the BFR training.

We have divided the advanced workout so that we exercise a different body part every 5 days. This 5 day routine is shown below:

1. Monday – Chest Exercises
2. Tuesday – Leg Exercises
3. Wednesday – Back Exercises
4. Thursday – Shoulders
5. Friday – Arms

TRADITIONAL HEAVY LOAD RESISTANT TRAINING

1. Uses lower reps (4-12) due to heavy loads
2. Take a one-minute rest between sets
3. Take a two-minute rest after completion of first round of exercises

BFR – Light Load Resistant Training

This method uses increased reps to create effectiveness in your training. Since the weights are light, they are easier to perform, with less risk of injury. The increased reps make up for using light weights. Instead of doing 10 reps, you are doing 30 reps. This causes the muscle to become exhausted and it makes the body respond and produce anabolic hormones.

Protocol for BFR

1. First Set uses 30 reps with 30 seconds of rest
2. Second set uses 15 reps with 30 seconds of rest
3. Third set uses 15 reps with 30 seconds of rest
4. Fourth set uses 15 reps with 30 seconds of rest
5. Total time for BFR is 30 minutes
6. You will do 3 different exercises in a 15 minute period
7. After each exercise of 4 sets you will rest for only one minute
8. After completion of 3 exercises or approximately 15 minutes, you will remove the bands for one minute.
9. You will then complete the final 3 exercises in approximately a 15 minute period, followed by removal of bands for a one minute rest.

BFR WORKOUT
DAY 1
CHEST EXERCISES

Dumbbell Flat Bench

1. Lie down on flat bench
2. Keep your feet flat on floor
3. Hold a dumbbell in each hand so that the palms face toward your chest
4. Lower the weights to the side of your chest (start of exercise)
5. Press the weights straight up (finish of exercise)

Standing Cable Crossovers

1. Grab the handles in each hand
2. Bend forward and extend your arms straight out to either side (start of exercise)
3. Then bring your arms around in a hugging motion until your hands cross each other (finish of exercise)

Pec Deck Machine

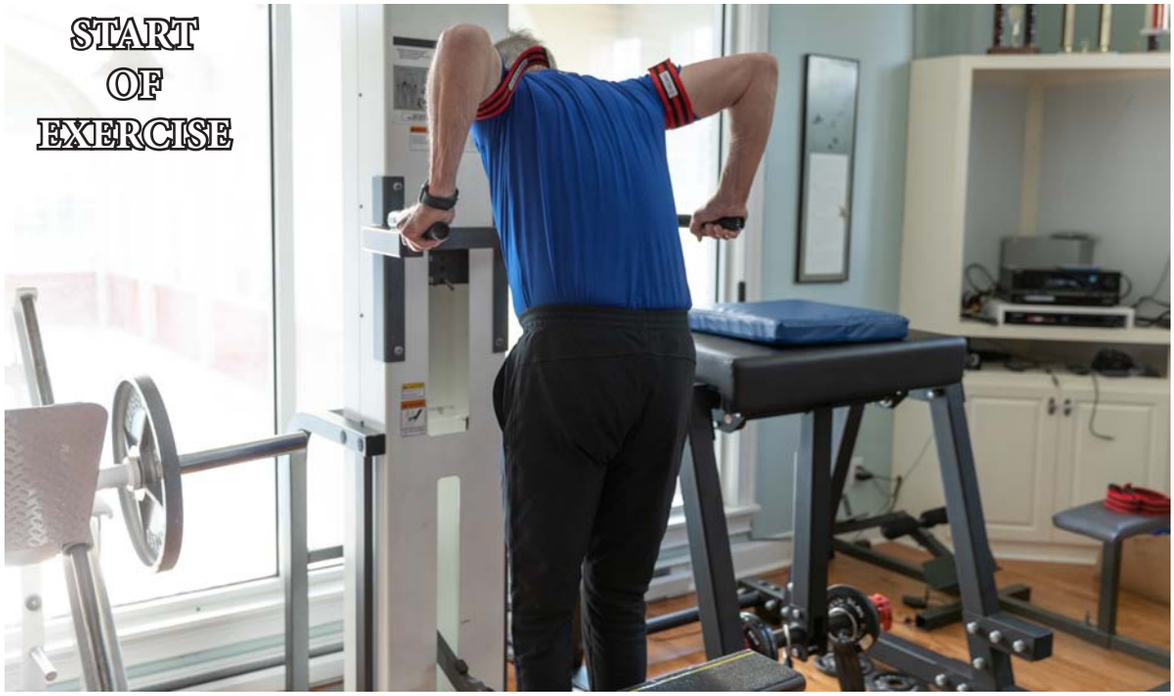
1. Place your hands and elbows on the pad (start of exercise)
2. Slowly squeeze your elbows together (finish of exercise)

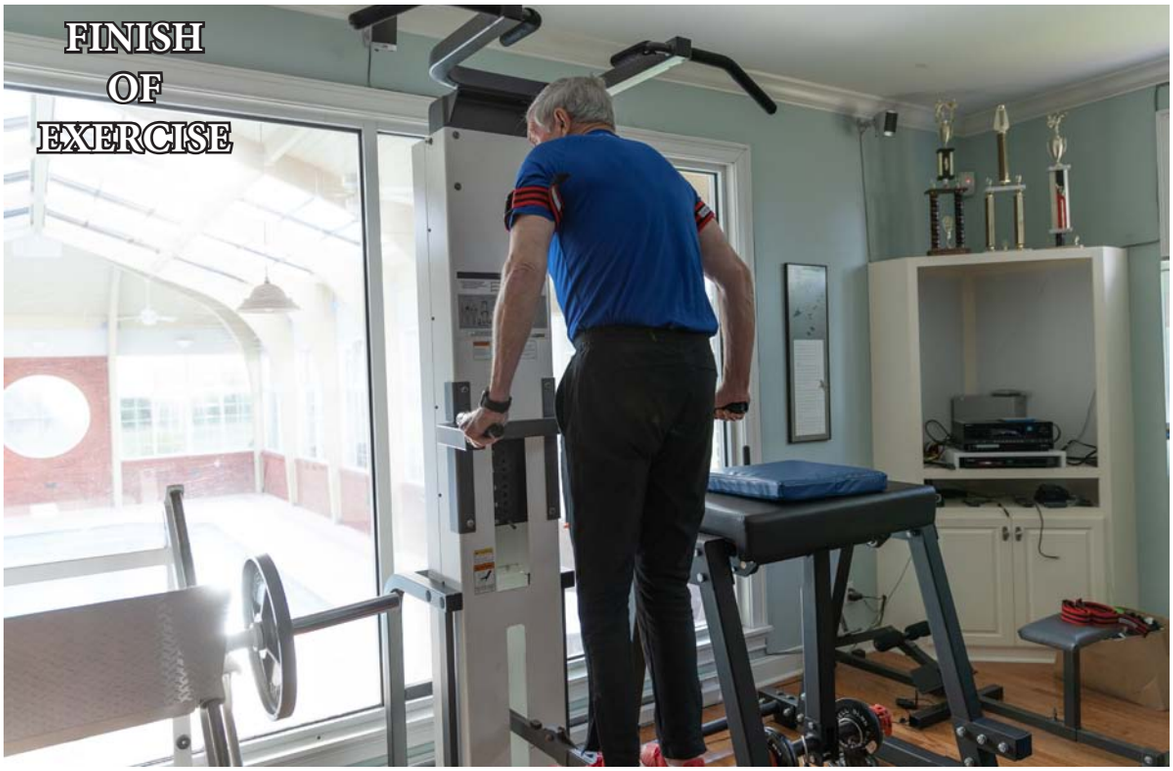
Pushups

1. Set your hands at a distance slightly wider than shoulder-width apart
2. Set your feet at about shoulder-width apart
3. Try to get your body aligned in a straight line
4. Slowly lower your body until your chest touches the floor (start of exercise)
5. Then push your body back up to the starting position (finish of exercise)

Machine Dips

1. Step on platform and get a comfortable grip on bars
2. Slowly lower yourself downward and keep your elbows close to your body (start of exercise)
3. After reaching bottom of movement downward, then push your body back up to the starting position (finish of exercise)





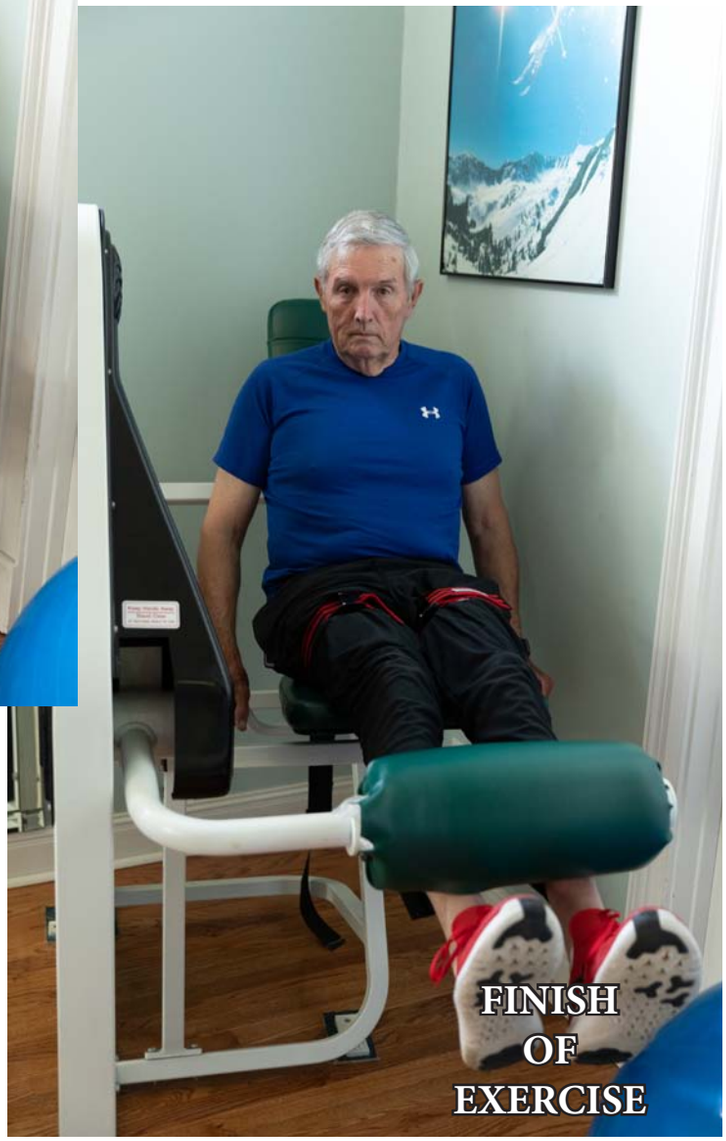
Seated Machine Bench Press

1. Sit with your back firmly supported against the backrest
2. Grasp the handles firmly with a full grip (start of exercise)
3. Perform a pressing motion until your are arms are fully extended (finish of exercise)

BFR WORKOUT DAY 2 LEG EXERCISES

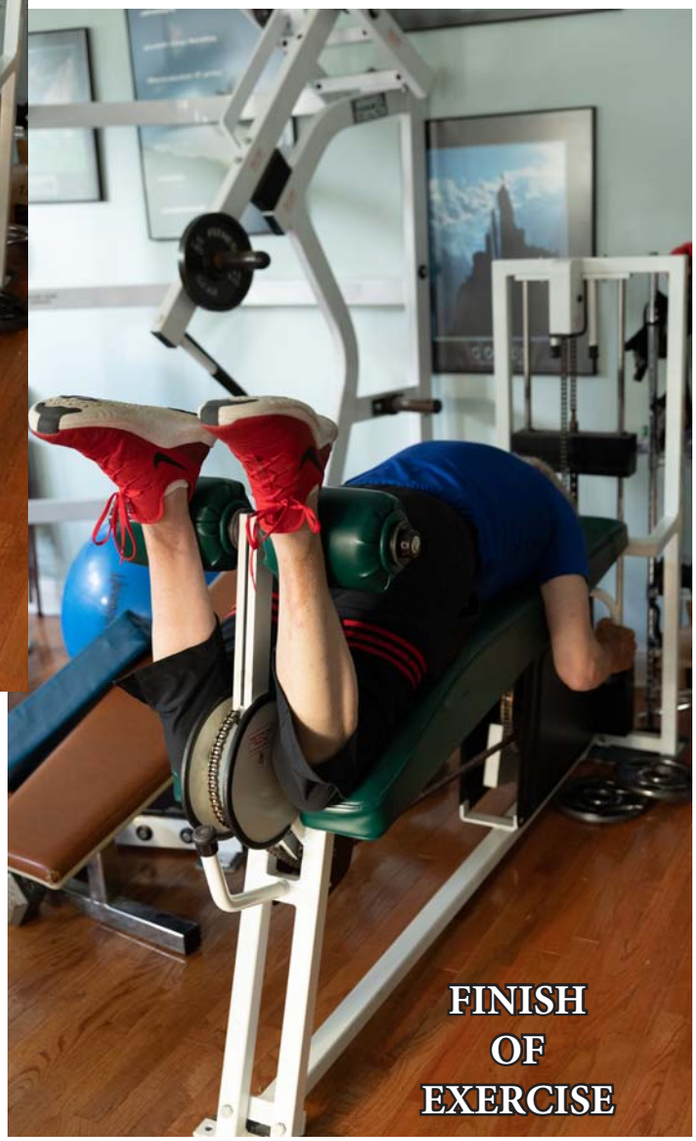
Leg Extensions

1. Sit on machine and hook your feet under the padded support (start of exercise)
2. Extend your legs outward (finish of exercise)



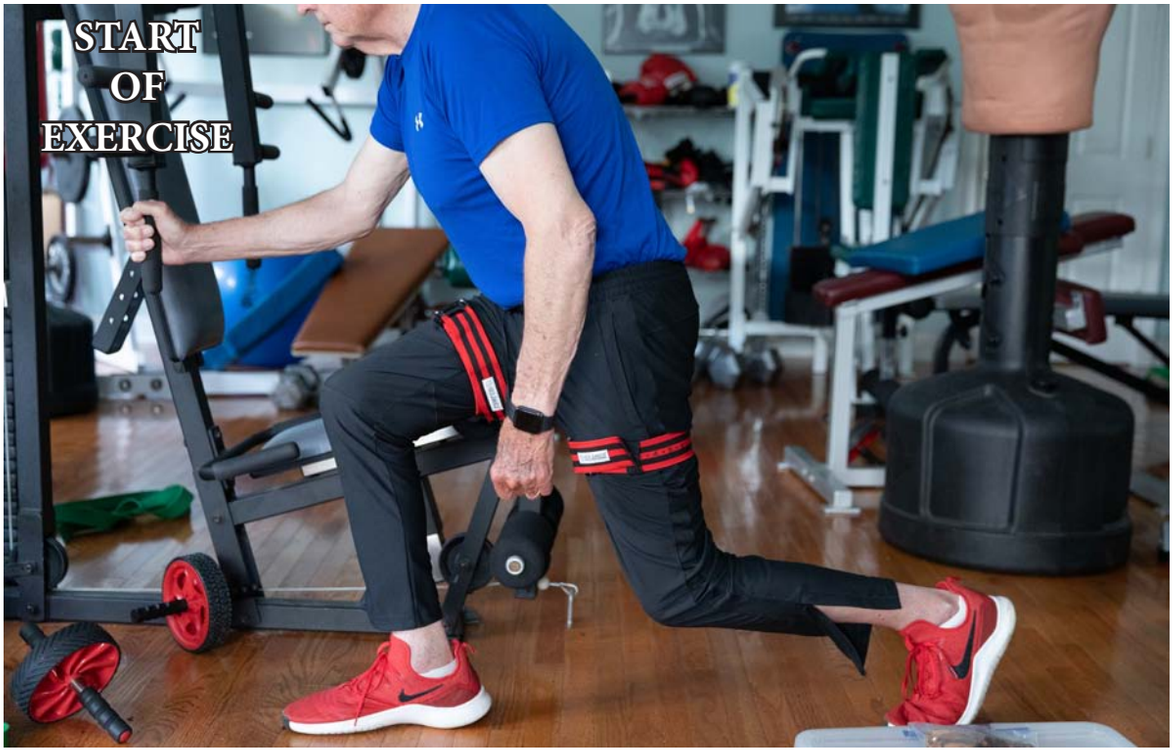
Leg Curls

1. Lie face down and hook your heels under the padded support (start of exercise)
2. Curl your legs up as far as possible (finish of exercise)



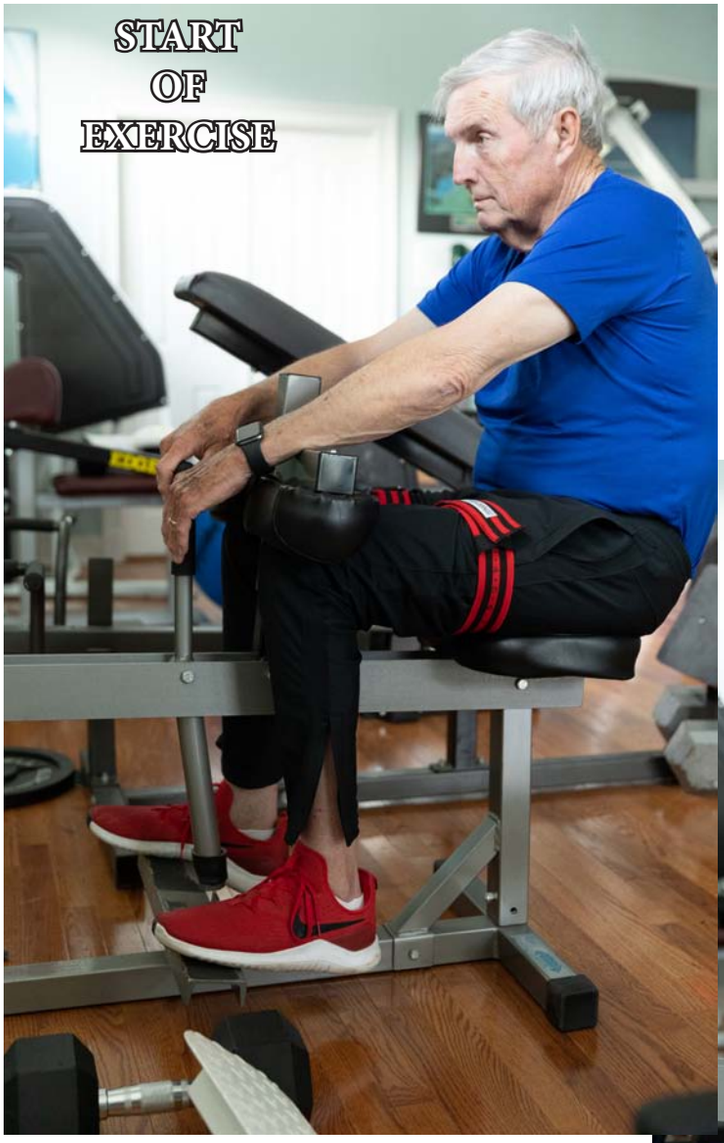
Lunges

1. Step forward with one leg, lowering your hips until both knees are bent at about 90-degree angle.
2. Slowly lower until your knee touches the floor (start of exercise)
3. Then push back up to the starting position (finish of exercise)



Seated Calf Raises

1. Place your knees under the support bar and put your toes on the bottom bar.
2. Slowly lower your heels as close to the ground as possible (start of exercise)
3. Then press with your toes upward as far as possible (finish of exercise)



Seated Stationary Squat

1. Hold to a bar in front of you
2. Bend your knees until they are at a 90-degree angle (start of exercise)
3. Hold for one minute and then stand up (finish of exercise)

Machine Leg Press

1. Position feet about shoulder width apart
2. Lower weight until your legs form a 90-degree angle (start of exercise)
3. Push up with your heels until the legs are extended (finish of exercise)

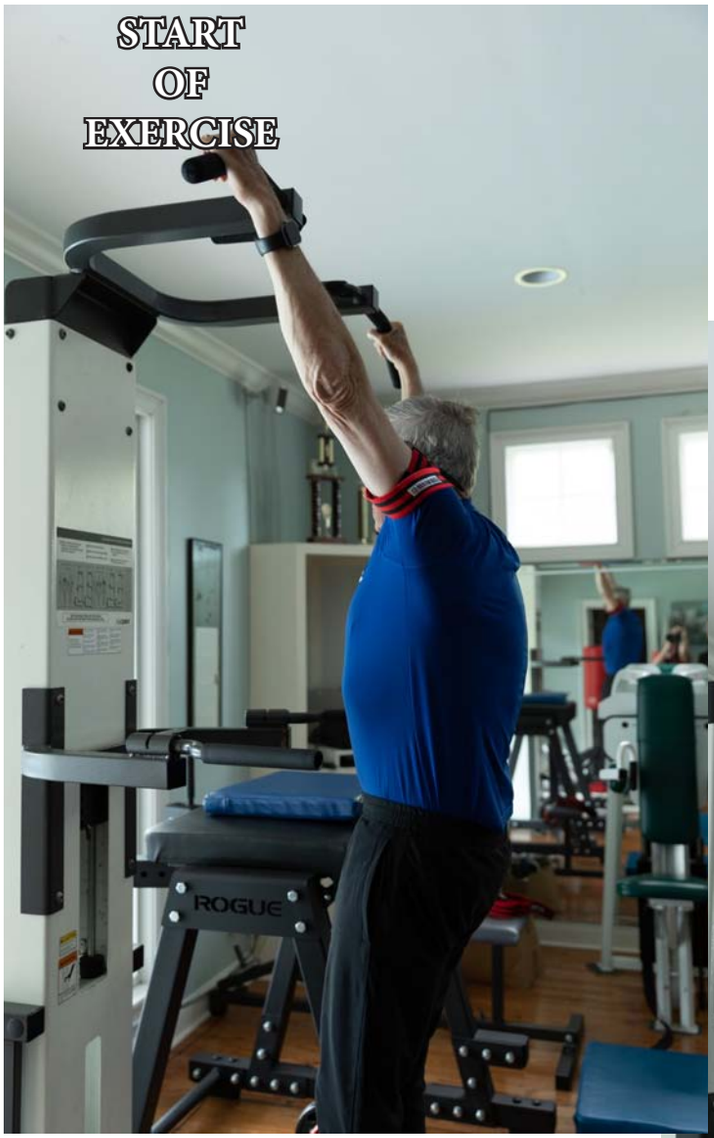
Hack Squat Machine

1. Take a shoulder-width or slightly wider stance with toes pointed slightly outward
2. Grab the handles and slowly lower until your legs form a 90-degree angle (start of exercise)
3. Then push through your heels and fully extend the hips and knees (finish of exercise)

BFR WORKOUT
DAY 3
BACK EXERCISES

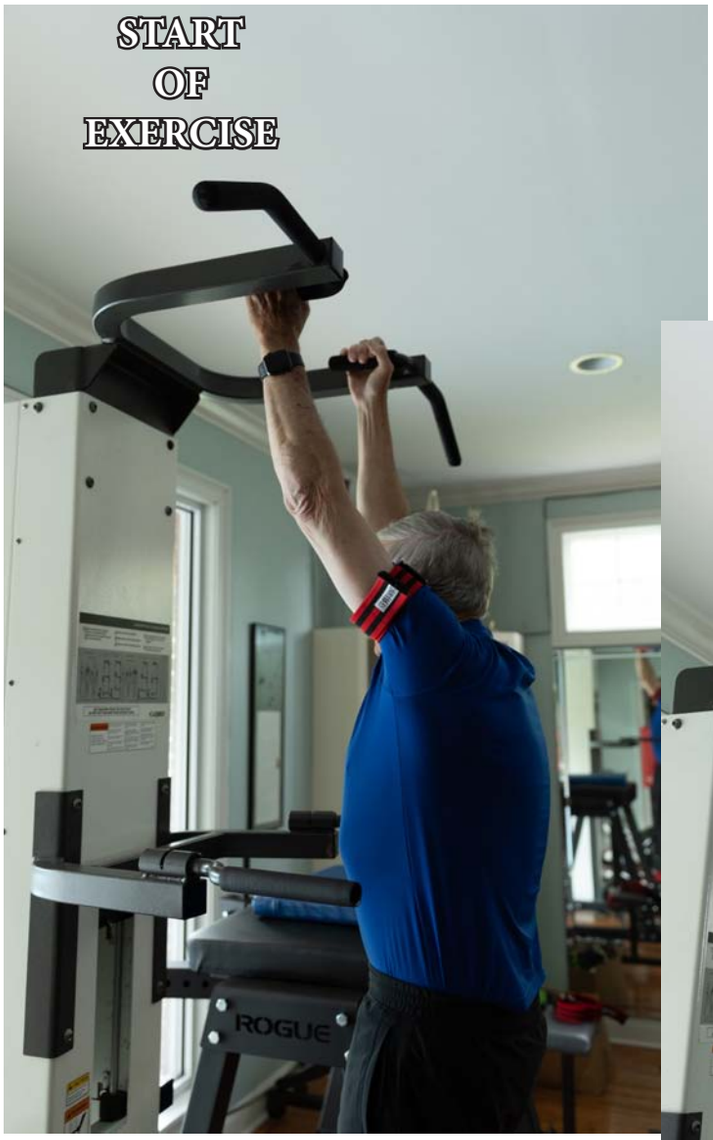
Wide Grip Pull-ups to Front

1. Use overhead grip with arms extended (start of exercise)
2. Pull yourself up and try to touch the top of your chest to the bar (finish of exercise)



Close Grip Pull-ups

1. Grasp handle with arms extended (start of exercise)
2. Pull yourself up and try to touch your chest to your hands (finish of exercise)



Lying T Bars Rows

1. Lie down and grasp bar with feet together and arms extended (start of exercise)
2. Lift the weight up until it touches your chest (finish of exercise)

One Arm Dumbbell Rows

1. Place one hand and leg on bench for support
2. Take a dumbbell in the other hand and bend forward until your upper body is nearly parallel to floor (start of exercise)
3. Hold the weight at arm's length with palm inward (start of exercise)
4. Lift the weight up to your side (finish of exercise)

Close Grip Pull-downs on Machine

1. Grasp the bar with both hands near each other and palms facing upward and arms extended (start of exercise)
2. Pull the bar downward until it touches your chest (finish of exercise)

Standing Two Arm Pull-downs

1. Grab the bar with both hands about shoulder width apart (start of exercise)
2. Drive the bar down until it touches your abdomen (finish of exercise)
3. Keep the bar straight when going down

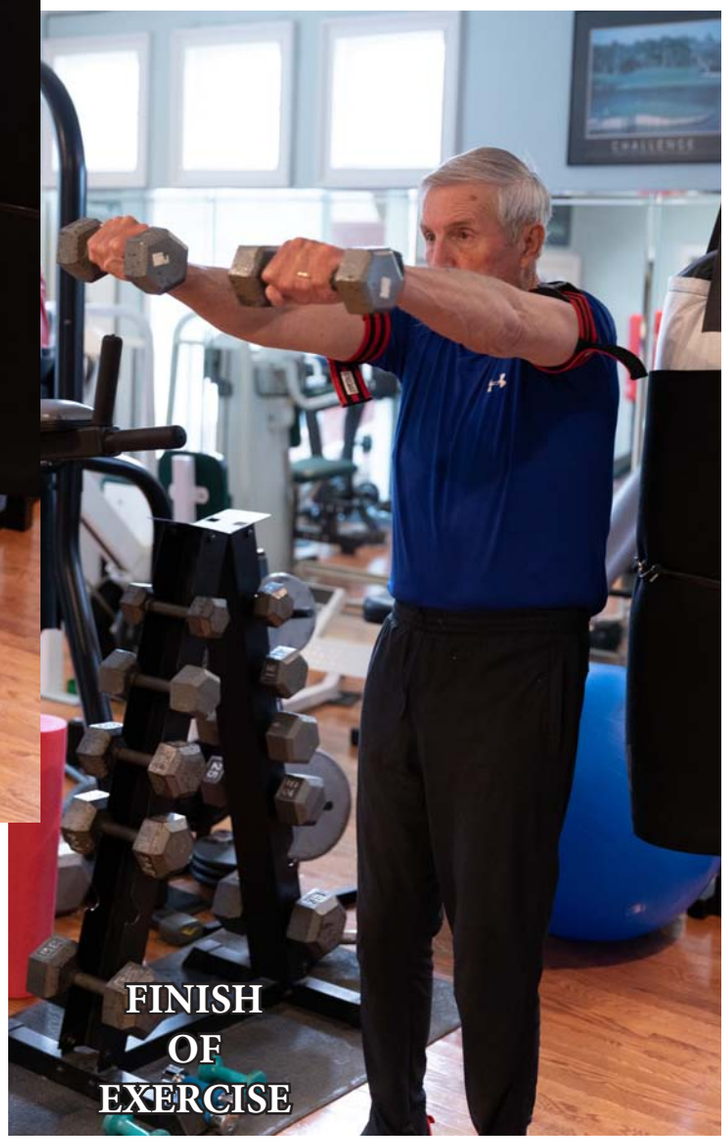
BFR WORKOUT DAY 4 SHOULDER EXERCISES

Hammer Strength Shoulder Machine

1. Grab the handles at shoulder level (start of exercise)
2. Push the weight straight up until your arms are extended (finish of exercise)

Front Dumbbell Raises

1. Stand with dumbbells in each hand with palms facing backwards (start of exercise)
2. Raise both dumbbells parallel to shoulder (finish of exercise)



Standing Lateral Raises

1. Hold the dumbbells at your side at arm's length (start of exercise)
2. Lift the dumbbells out and up to either side at the same time. At top of exercise turn your wrists so rear of dumbbell is higher than front (finish of exercise)

Kettlebell Swing

1. Grap the kettlebell with palms facing your body and thumbs are wrapped around the handle (start of exercise)
2. Swing the kettlebell upward as high as you can (finish of exercise)

Arnold's Presses

1. Raise dumbbells to your shoulder with palms toward you (start of exercise)
2. Press dumbbells overhead until arms are extended (finish of exercise)

Smith Machine Upright Rows

1. Grasp the bar with the arms extended about shoulder width apart (start of exercise)
2. Lift it straight up until it touches your chin (finish of exercise)

BFR WORKOUT DAY 5 ARM EXERCISES

Standing Barbell Curls

1. Let the barbell hang down in front of you with your palms facing away from your body (start of exercise)
2. Curl the barbell upward toward your chest and contract the bicep at the top of the exercise (finish of exercise)

Preacher Curls

1. Place your chest against the pad and place the barbell over the pad with your arms extended (start of exercise)
2. Curl the barbell all the way up and contract the bicep (finish of exercise)

Cable Curls with Straight Bar

1. Stand close to the machine
2. Start with arms extended in front of you and palms facing away from you (start of exercise)
3. Curl upward to top of your chest (finish of exercise)

Lying Triceps Extension with Easy Curl Bar

1. Lie down on bench with easy curl bar and arms extended
2. Lower the bar to your forehead (start of exercise)
3. Slowly push the bar upward until the arms are fully extended (finish of exercise)

Machine Assisted Dips

1. Step up on the platform and get a comfortable grip on the bars
2. Slowly lower yourself downward and keep your elbows close to your body (start of exercise)
3. After reaching the bottom of movement downward, then push your body back up to the starting position (finish of exercise)

Flat Bench Assisted Dips

1. Place a bench behind you and a chair in front of you
2. Place your hands on the bench behind you with palms facing down. Then place your feet in the chair in front of you.
3. Slowly lower your body until there is an angle less than 90 degrees (start of exercise)
4. Using your triceps then push yourself back up with arms extended to the starting position (finish of exercise)

Summary

Blood Flow Restriction (BFR) training is, without a doubt, one of the best revolutionary exercise programs that I have ever encountered. The goal of BFR training is to decrease the time it takes to build strength and muscle size. By using special elastic straps, you reduce the movement of blood flowing back to your heart so the body part you're working out becomes engorged with blood. For example, you can tightly wrap your upper arms before doing dumbbell curls to work out your biceps. This occlusion of the vein increases your blood's lactate concentration. This allows you to work out at a lower intensity while giving the feeling of a much harder workout to your body. When your brain thinks your body is experiencing a difficult physical challenge, it signals the pituitary gland to produce hormones that cause muscle growth.

The major applications for BFR are:

1. Rapid recovery from training and competition. Muscle fatigue, soreness, and inflammation can set in when you have just finished a hard workout or competition. Rapid recovery is a crucial component of any active lifestyle and using BFR can enhance blood circulation to help your body feel its best in a shorter period of time.
2. Rehabilitate stronger from injury or surgery. Whether you undergo surgery, are recovering from an injury, face physical limitations, or experiencing minor aches and pains, the rehabilitation process can be slow and frustrating. Incorporating BFR protocols into your rehabilitation regimen reduces muscle atrophy and insures rapid recovery.
3. Enhanced performance by improving your strength, speed, stamina, and mobility. BFR moderates your blood circulation in order to make your brain think your muscles are working harder than they actually are with lighter resistance. BFR enhances performance levels and improves overall fitness with less impact on the body.
4. Enhanced uptake of glucose into the skeletal muscle that can decrease insulin levels, insulin resistance, and HbA1C. This can improve blood glucose control in metabolic syndrome and diabetes mellitus.

Many of us wish for a strong body and better health. BFR can allow you to build muscle faster with lighter weights and low risk of injury. Start on the journey to ultimate fitness with BFR today. – *Jerry Williams, MD, FACC, FACP*

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