EFFECTS OF LOW-INTENSITY RESISTANCE TRAINING WITH BLOOD- FLOW RESTRICTION ON MUSCLE

Abstract

Blood flow restriction (BFR) during low-intensity resistance training has recently drawn a lot of interest because of its potential to increase muscle strength and hypertrophy. Blood flow restriction (BFR) during low-intensity resistance training has recently drawn a lot of interest because of its potential to increase muscle strength and hypertrophy. The purpose of this study is to investigate the scientific evidence that exists about the effects of blood flow restriction combined with low-intensity resistance exercise on muscle physiology and performance. An explanation of the basic processes governing the BFR training approach, as well as its effects on muscle oxygenation, cellular metabolism, and hormone release, is given in the review's opening paragraph. In-depth analysis of the complex interactions between BFR and conventional resistance training is provided, emphasising how low-intensity loads combined with limited blood flow cause muscle stress and set off adaptive responses. In conclusion the present research shows that coupled with low-intensity resistance training and blood flow restriction can be a successful and secure method for enhancing muscle adaptations. However, further investigation is required to clarify the ideal procedures, long-term effects, and potential drawbacks of this training approach. Athletes, fitness enthusiasts, and rehabilitation specialists may eventually find it helpful to understand the underlying mechanics and practical applications of BFR training in order to improve training methods and achieve desired results.

Keywords: blood flow restriction training; low intensity resistant training with BFRT; rehabilitation

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I. INTRODUCTION

Recently, Blood-Flow Restriction has received a lot of interest as an alternative for high intensity resistance training in rehabilitation facilities, gyms, etc. It also aids in increasing muscular mass, strength, and endurance during workouts. BFR training's rationale is to totally obstruct venous return while partially lowering arterial inflow. Pressure cuffs are placed on the proximal portion of the arm or leg to accomplish this.

The minimal pressure necessary to completely block arterial inflow and venous return is called limb occlusion pressure (LOP), and it is advised that BFR be given to the individual using this proportion of personalised pressure. The pressure cuffs should target a tightness of 6-7 on a scale of 10. Recent research suggest that occlusion pressure increases may enhance the training-related response to BFRT.

The amount of exercise with BFR, the pressure of partial or complete occlusion, the type of occlusion (continuous or intermittent), and the degree of activity (low, moderate, or high) all have an impact on the adaptations to exercise with BFR. [1]. The American College of Sports Medicine (ACSM) recommends lifting weights at least 70% of one's concentric one repetition maximum (1-RM) to see results in regards to muscle hypertrophy [2].

This idea has recently been refuted by the use of Blood-Flow Restriction (BFR) with Low-Intensity Resistance Exercise with, which consistently demonstrates that hypertrophic adaptations may be elicited with markedly reduced exercise intensities (50% 1-RM)[3]. Skeletal muscle growth, enhanced strength, and improved endurance have been seen when training with low intensity (20-30% concentric 1-RM) and venous blood-flow restriction (VBFR) are coupled [2]. The patient engages in resistance training with modest intensity of 20–30% of 1 repetition maximum (1RM) of high repetitions (15–30 repetitions) each set, and brief rest periods (30 seconds) between sets.

II. CONTRAINDICATIONS OF BFRT

Table 1: Contraindications of BFRT [4]

Active cancer/tumors[a]	History of thrombosis	Renal compromise[a]
Arterial calcification[a]	Lymphectomies	Respiratory disease
Cardiovascular disease	Medications that increase clotting risk	Severe uncontrolled hypertension[a]
Crush injuries[a]	Obesity[a]	Sickle cell anemia trait[a]
Extremity infection	Open fractures[a]	Smoker
Family history of clotting disorders	Peripheral vascular compromise[a]	Uncontrolled diabetes mellitus
Hemophilia	Poor circulatory system	VTE

III. RISK FACTORS OF BFRT

Age>/ =40 yr	Dialysis	Lymphectomies	Physical inactivity
Arterial calcification	Fractures of pelvis, hip or long bones	Major general/ orthopaedic surgery	Pregnancy
Atherosclerotic vessels	Dermis or vessels grafts	Multiple traumas	Prior history or family history of VTE
Blood clotting disorders	Hypertension	Nonhealing soft tissue injuries	Renal compromise
Cancer/tumor	Immobility	Obesity	Sickle cell anemia
Central catheter	Implanted medical device	Open fractures	Spinal cord injuries
Crush injuries	Increased intracranial pressure	Oral contraceptives	Stroke
Diabetes	Infection	Peripheral vascular disease	Varicose veins

IV. PHYSIOLOGY

When used properly, the Blood-Flow Restriction training approach allows blood to enter the musculature via arterial inflow, but the veins are constrained to prevent blood from leaving the working muscle during exercise. Compared to an unoccluded limb at rest, more blood is still flows to the muscles of the affected limb. A series of processes lead to local and systemic endocrine and metabolic reactions in the muscles as a result of the following venous pooling and hypoxia brought on by a relative decline in blood flow. The low oxygen atmosphere is hypothesised to support increasing muscle protein synthesis to increase muscle size, changing muscle satellite cell gene regulation, boosting muscle fibre recruitment, and enhancing muscular endurance.

Reactive oxygen species (ROS) are produced which cause changes in cellular protein metabolism and encourage the formation of satellite cells, the buildup of metabolites causes muscle hypertrophy. The pressor reaction during exercise, a sequence of CV adjustments brought on by the contraction of muscle that during exercise increases systemic vascular resistance and heart rate, is likewise started by this metabolic cascade.

Based on the length, pressure, and intensity of training during BFR, studies have demonstrated an increase in muscle strength, bulk (hypertrophy), endurance, and some alterations in aerobic and anaerobic capacity. [4]

V. METHODOLOGY

Three electronic databases, PubMed, Scopus, and Google Scholar, were searched. Studies that have been published since January 2015 were included in the search method. However, some of the included review articles incorporated data from excellent research that, in some cases, were conducted before 2005. The pre-established search terms were: “blood flow restriction training" and "low intensity resistant training with BFRT" and "rehabilitation".

To lessen variability, all published research was acquired from the literature databases, arranged by intervention date and type, and then double entries were eliminated. This review covered randomised, double-blind studies (randomised controlled trials, RCTs) as well as systematic reviews, observational cohort, cross-sectional, meta- analyses and case-control.

Studies using experimental models and animals were not included in the study. Studies with insufficient sample sizes, inadequately defined selection criteria, or that included participants receiving medication for a different condition that affected bone or muscle metabolism were also disregarded. Finally, the review did not include case reports, editorials, letters to the editor, or conference proceedings.

VI. DISCUSSION

There are various impacts of blood flow restriction &low intensity resistance exercise (BFR + LIRE) on hormonal factors, transcriptional factors with relation to muscular enlargement, changes in hemodynamic, endothelial function and autonomic function, which are discussed below.

VII. BFR & LIRE'S EFFECT ON MUSCLE HYPERTROPHY-RELATED HORMONAL FACTORS

Immediately after a single session of high-intensity resistance training, muscle growth and enhanced strength are typically believed to be related to the selection of high threshold motor units [5]. Increased mechanical strain, hormonal changes, and metabolite accumulation are all brought on by the recruitment of these motor units. According to earlier research, BFR & LIRE produces akin endocrine effects and muscular adaptations, such as an increase in muscular hypertrophy, as compared to high intensity resistance training [6].

Pierce and colleagues also noted a short term 9-fold rise in serum GH from baselevel through the end of knee extension exercise at 20% maximum voluntary contraction (MVC) with BFR, in addition to these long-term advantages. Others have seen GH rises up to 290 times higher than baseline levels, with GH responses to BFR & LIRE being comparable to or even exceeding those observed after high-intensity resistance training at intensities of roughly 70% 1RM. [7].

VIII. BFR & LIRE'S EFFECT ON MUSCLE HYPERTROPHY- RELATED TRANSCRIPTIONAL FACTORS

Skeletal muscle hypertrophy is mostly controlled by transcriptional mechanisms, such as the modulation of mRNA [8].

There is increament in muscle protein synthesis and ribosomal S6 kinase 1 (S6K1) phosphorylation are following a single bout of BFR+LIRE, according to a recent study by Fujita and Yasuda. The modulation of muscle growth linked genes including protein kinase B

(AKT), mTOR etc. after BFR+LIRE may be the cause of these abrupt alterations in transcriptional factors linked to muscle growth.

By activating the mTOR pathway, it a study it showed that because of BFR, brief periods of hypoxia and is chaemia were seen on improvement of adaptations in skeletal muscle cells' development and survival. Additionally, hypertrophy depends on the modulation of vascular endothelial growth factor (VEGF) is a essential controller in vasculogenesis and development of new blood vessels and can be triggered by hypoxia and lactate buildup [8].

IX. BFR & LIRE'S EFFECT ON HEMODYNAMICS CHANGES

It is widely known how BFR with RT affects hemodynamic parameters. Prior research suggested that blood pressure increase during moderate to intense resistance training with BFR on CVS and skeletal muscle performance. Significant rise in mean arterial pressure among large muscle groups, especially during isometric contractions were seen [9].

Although resistance training is thought to naturally trigger the pressor reaction brought on by exercise, it's vital to remember that BFR can cause blood pressure to vary substantially more than typical exercise does [10].

X. BFR & LIRE'S EFFECT ON ENDOTHELIAL ACTIVITY

BFR & LIRE do not majorly changes the function blood vessel as measured by the arterial conformity , despite the fact that the effect of Low resistance exercise with BFR on vascular function has not been thoroughly reported. Additionally, it has been demonstrated that walking while using BFR promotes carotid arterial compliance and muscle hypertrophy simultaneously [11].

Additionally, Credeur et al. hypothesised that endothelial function in brachial arteries was compromised after 3 months of handgrip exercise training along with BFR. Endothelin I is stimulated, which increases the backward flow in exercising muscle, was cited by the authors as the explanation for the functional impairment caused by BFR [12].

Although endothelial function in the vasculature is crucial for understanding the mechanisms of underlying changes in function following BFR & LIRE but lack of researches and mixed results are seen.

XI. BFR & LIRE'S EFFECT ON AUTONOMIC ACTION

Low resistance exercises’s effects on autonomic function in sick people, including patients with hypertension and heart failure, have shown improved parasympathetic nerve activity. In healthy young and old people, however, low resistance exercises doesn't improve activity of parasympathetic nerve to the same extent. By using experimental occlusion, it has been found that blood flow restriction can boost the autonomic nervous system's (ANS) reaction [13].

Researchers hypothesised that the intense exertions on the limbs caused by the BFR cuff increases baroreflex, resulting in narrowing of wall of blood vessels and increased responsiveness to blood pressure. Important components include baroreflex sensitivity and autonomic function of vasomotor regulation. Due to the venous blood pooling and the reduced femoral arterial blood influx, applying BFR alone to the legs significantly reduced blood flow, including cardiac output, according to Iida and colleagues. [13].

This BFR causes blood flow to be retained in the lower extremities, which then results in hemodynamic alterations that affect the autonomic nervous system. Orthostatic intolerance following bed rest has been proven to be prevented with the ensuing adaptation for lower body negative pressure. As a result, BFR might be a valuable technique to encourage appropriate autonomic function, which could ultimately aid elderly people in reducing their risk of fainting and falling.

Different protocols choices are discussed below. PROTOCOL CHOICE

- raising the BFR pressure while maintaining the level of exercise,
- steady partial BFR pressure as exercise intensity rises,
- steadily rising exercise intensity and constant total BFR pressure and
- rising BFR pressure as exercise intensity increases .

A total of 12 sessions of training composed of repeated bouts of 2 min treadmill running with BFR mixed with recovery of 1-min without BFR. A number of tests to assess muscle strength, aerobic, and anaerobic performances were performed. Muscle strength, anaerobic power and aerobic characteristics such as VO2 max, time to fatigue, velocity at VO2 max and running economy can be assessed to evaluate the effect of BFRT [2].

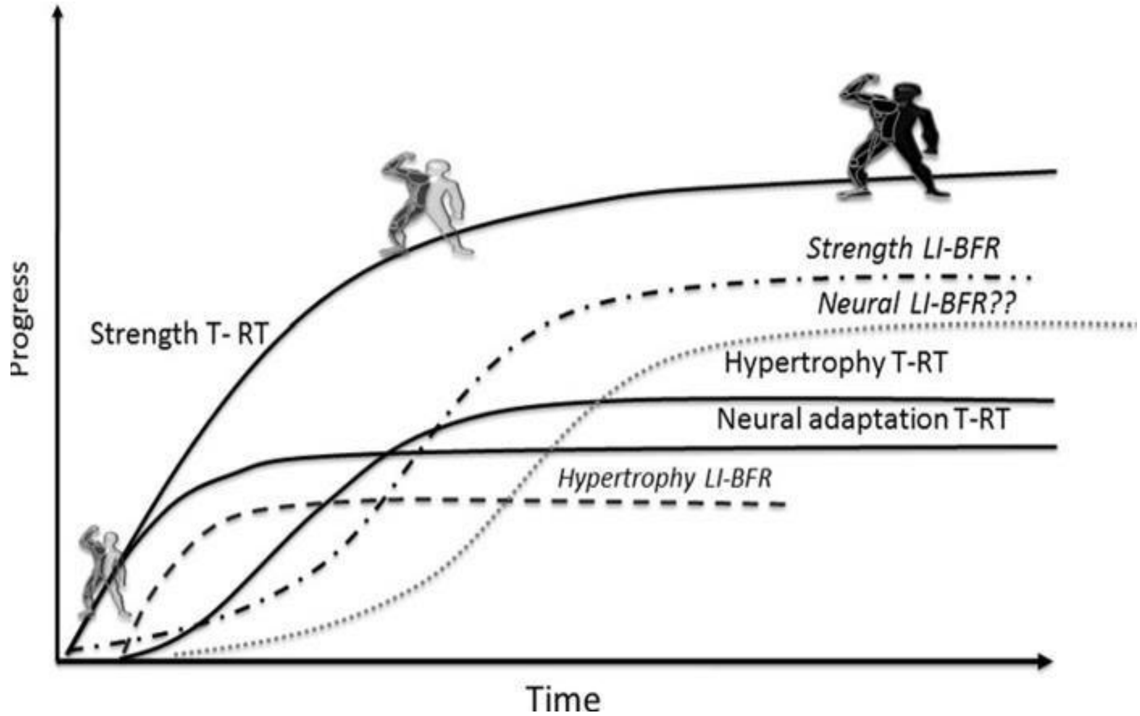

Figure: 1 Traditional vs. Low-Intensity Blood-Flow Restriction Exercises

Theoretically Reverse Pattern Adaptations. This graph shows the potential interplay of neural changes, hypertrophy, and strength during both low intensity Blood-Flow Restriction exercise (LI-BFR) and Traditional Resistance Training (T-RT) [2]. The progress-time graph for T-RT, there is an enhancement of strength initially & is due to change in muscle growth, which is then followed by neural adaptations. Whereas in the LI-BFR progress-time graph depicts that the pattern followed by LI-BFR might occur the other way around, concluding that combining BFR with low intensity exercise training marks to be beneficial than Blood-Flow Restriction with walking.

In a study in 2019 to understand the Blood-Flow Restriction training's proximal, distal, and contralateral effects on the lower extremities [14]. When in a study where healthy patients were randomized to unilateral low-load BFR training or to a non-BFR control group, a statistically greater increament in strength was seen proximal and distal to the BFR compression cuff when compared with both the non-compression cuff extremity and the control group. The improvement in the BFR group compared with controls were found out to be an approximate twice. A significant amount of growth occurred in thigh girth and knee extension strength in the non- compression cuff BFR extremity compared to control group.

Low-load Blood-Flow Restriction (LL-BFR) compared to high resistance training results in similar morphological and mechanical changes to the Achilles Tendon. [13]. The study provided first evidence that LL- BFR can increase similar Achilles Tendon morphological and mechanical properties as conventional High-load Resistance training. The study included 55 male volunteers (27.9 ± 5.1 yrs) were randomly divided into the following three groups:

- LL-BFR (20-35% of 1RM),
- High Load (70-85% 1RM) or
- a non-exercising control group (CON).

Furthermore, the girth of gastrocnemius medialis muscle and plantar flexor’s strength significantly increased in both training groups as compared to the non-exercising control group.

3 ACL reconstruction cases, 3 knee OA cases, 13 older adult at risk of sarcopenia and 1 patient with myositis were taken into consideration in a small number of research on the impact of blood-flow restriction in clinical musculoskeletal rehabilitation. Low-load BFR training is found to be more beneficial and tolerated than low- load training, making it a promising clinical rehabilitation intervention. [15].

XII. CONCLUSION

This research concluded that there are various effects of Blood-Flow Restriction Training along with Low- Intensity Resistance training on the physiology of muscle. This research supports the evidence that using Low- Intensity Resistance training along with Blood-Flow Restriction is able to generate muscle hypertrophy, increase in muscular strength, endurance, aerobic capacity, anaerobic capacity and an overall fitness. This data can be used further in rehabilitation purposes and general fitness purposes.

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