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**A LITERATURE REVIEW ON EFFECTIVENESS OF THE BLOOD FLOW RESTRICTION TECHNIQUE TO REDUCE PAIN AND INCREASE MUSCLE STRENGTH**

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**Background:** Blood Flow Restriction Training (BFRT) is a promising rehabilitation and exercise method that uses pressure cuffs to induce muscle fatigue and metabolic stress, potentially improving muscle strength and pain management. A systematic review found BFRT significantly reduces pain and enhances muscle strength.

**Study design:** Systematic Review.

**Objective:** The goal of this research of the literature was to find out whether the BFRT is effective in reducing pain and strengthening muscles.

**Method:** The authors conducted a PubMed, ScienceDirect, and Google Scholar search and collected the reviews consisting of total systematic analyses, RCT and experimental studies regarding the current evidence of the effect of BFRT on reduce pain and increase muscle strength.

**Results:** BFRT significantly effect on reduce pain and increase muscle strength. The articles were collected in full text. Out of the 46 articles that were discovered, 20 were selected for evaluation.

**Conclusion:** BFRT has been demonstrated in this research review to significantly reduce pain and increase muscle strength.

**Keywords:** Blood Flow Restriction Technique (BFRT), pain, muscle strength.

**INTRODUCTION**

Blood flow restriction (BFR) technique, also known as Kaatsu training, was created in the 1970s and 1980s by Yoshiaki Sato of Japan. to ensure that create mechanical compression from the underlying vasculature, this training technique involves reducing blood supply to a muscle by using an external constricting device, like a blood pressure cuff or tourniquet. BFR is used with the intention of encouraging blood to collect in the leg muscles' capillary beds away through the tourniquet.<sup>[1]</sup> During exercise, BFR is achieved by totally preventing venous return flow and just partially preventing arterial input. While exercising, a blood pressure cuff or restrictive straps are placed and inflated on the limb's top part to a pressure that can prevent arterial entrance while limiting venous return.<sup>[2]</sup>

Utilising BFR for training is a recently developed method for either preventing muscle atrophy or, maybe, inducing muscular growth. An inflated cuff or tourniquet is used the proximal end of an extremity during the process, and internal pressure is gradually increased until it limits venous efflux and arterial blood flow.<sup>[3]</sup> During all stages of rehabilitation, including bedrest, there have been indications restricting blood flow can help muscles adapt. as a method to support muscle adaptations. It is crucial to regain ambulation as soon as possible since muscle weakening and disuse atrophy can happen rather fast as a reaction to immobilization. Depending on your healing stage, physical activity may be delayed or even harmful. BFR in this situation offers a potentially practical stimulus to slow down the frequency of atrophy and preserve muscle strength.<sup>[4]</sup>

The Sports Medicine Institute of America recommends resistance training between sixty and eighty percent of a 1RM for maximum strength and muscular growth improvements. However, high-intensity exercise is often not feasible due to various reasons. Using BFR for Patients can benefit from training with age, injury, or weight gain similar results while reducing joint pressure. While LL-BFR can achieve similar results to high-load training, it remains to be seen if bone improvements can be achieved at the same efficacy as high-load training.<sup>[5]</sup>

There are two primary causes of muscle hypertrophy: mechanical strain and metabolic stress. Muscle growth results from elevated anabolic hormone levels brought on by mechanical strain. Anabolism of muscle tissue includes the release of hormones, hypoxia, and cell swelling brought on by metabolic stress. Normally dormant, myogenic stem cells become active in response to increasing muscle stress or a physical injury to a muscle, and they aid in both the development of new muscle fibres and the healing of damaged ones. It has been seen that 4–6 weeks of short-term, low-intensity BFR exercise increases muscular strength by 10%–20%. These increases were similar to those obtained from vigorous exercise in the absence of BFR. BFR training attempts to imitate

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the effects of vigorous exercise by employing a cuff to simulate a hypoxic environment. Light workouts can be done once the cuff is positioned close to the muscle being worked. Because the cuff restricts blood flow, low-oxygen blood builds up and raises proton and lactic acid levels. Low-intensity exercise and BFR training induce the same physiological changes in the muscles as high-intensity exercise, resulting in cell edema, hypoxia, and hormone release.<sup>[6]</sup>

## **METHODOLOGY**

**Study design:** It is a systematic review, which was described according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

### **Eligibility criteria:**

#### **Inclusion criteria:**

- Included were articles addressing the results of muscle strength, discomfort, and blood flow restriction techniques.
- There were articles available exclusively in English.
- Articles with full text.
- Articles with full text from 2010-2023 have been included.

#### **Exclusion criteria:**

- Articles published in other languages were excluded.
- Articles published below the year 2010 were excluded.
- Articles not containing information regarding BFRT

**Information sources:** Internet-based search engines that were used to collect journals are Google Scholar, PubMed and ScienceDirect. Journals from the year 2010 -2023 were searched.

**Search strategy:** Internet-based search engines that are used to collect journals are Google Scholar, PubMed and ScienceDirect.

**Selection process:** The authors identified articles according to the keywords. The whole text of the articles was gathered. A total of 46 articles were collected and only 20 articles were used in this study for the research. Articles were included from year 2010 to 2023. Articles include the incidence of effectiveness of blood flow restriction technique on reducing pain and increase muscle strength

**Data collection process:** The randomized controlled studies, systemic reviews and experimental studies that included evaluations of the information that was available on blood flow restriction technique associated with reducing pain and increase muscle strength were gathered by the authors through searches on PubMed and Google Scholar.

Study Flowchart



REVIEW OF LITERATURE:

Sr no.	Author	Title	Duration of treatment	Outcome measures	Study design	Conclusion
1.	Pehzaan Sarfabadi et al, 2023 [6]	Elevating athletic performance: Maximizing strength and power in long jumpers through combined low-intensity	6 weeks	Muscle strength	Experimental study	A study shows that combining low-intensity BFR and HI- RT enhances long jumper performance and strength, with future research focusing on individual muscle training.

		blood flow restriction and high-intensity resistance training				
2.	Sandra Rodrigues et al, 2022 [7]	Effect of Blood Flow Restriction Technique on Delayed Onset Muscle Soreness: A Systematic Review	-	Muscle strength, pain, muscle girth	Systematic Review	According to the study, eccentric exercise along with high restrictive forces can cause DOMS, lengthen the recovery period, and result in strength improvements and muscle hypertrophy. Applying post conditioning with a preset restrictive pressure, with protocols varying from occlusion one to three times and three to five minutes, can help protect DOMS.
3.	Ian Burton et al, 2022 [8]	Blood Flow Restriction Training for Tendinopathy Rehabilitation: A Potential Alternative to Traditional Heavy-Load Resistance Training	9 weeks	Patellar Instability scale, VAS for pain	Randomized controlled trial	LL-BFRT has been shown to improve muscular adaptations and tendon function in healthy tendons, particularly Achilles and patellar tendons. Despite limited research on its effects on other musculoskeletal conditions, BFRT is an encouraging method for tendinopathy rehabilitation, complementing HL-RT interventions.
4.	Shuoqi Li et al, 2021 [9]	Effects of Blood Flow Restriction Training on Muscle Strength and Pain in Patients with Knee Injuries	-	Muscle strength, pain	A comprehensive analysis and meta-analysis	According to a study, L-BFR and high resistance exercise load considerably enhanced strength of muscles and lowered leg pain perception, suggesting that they could be used as a useful intervention for the recovery of knee injuries.
5.	Alexios Pitsillides et al, 2021 [10]	Blood flow restriction training in patients with knee osteoarthritis: Systematic review of randomized controlled trials	-	Muscle strength, pain	A Systematic review	study shows that BFR-TR method is ideal for managing KOA pathology, as it lessens discomfort and enhances muscular adaption. A six-week rehabilitation program with a maximum tolerable workload and rest period is recommended.
6.	Ryan J. Wortman et al, 2021 [11]	Blood Flow Restriction Training for Athletes A Systematic Review	-	Muscle strength, muscle size	A Systematic review	review suggests that Blood flow Resistance Training (BFR) can enhance strength and performance in healthy athletes, although there is variation within the extent to which BFR can increase muscle size.
7.	Cristina	Comparison of Blood	-	Muscle	Systemi	According to the reviewed

	Bobes Álvarez et al,2020 [2]	Flow Restriction Training versus Non-Occlusive Training in Patients with Anterior Cruciate Ligament Reconstruction or Knee Osteoarthritis: A Systematic Review		strength, CSA, Pain, Functionality and/or Life Quality	c review	research, BFR exercise may have benefits for CSA and muscular strength comparable to high-intensity training. It could also yield outcomes comparable to low-intensity training in terms of life quality and degree of knee pain during exercise.
8.	Birk Mygind Grønfeldt et al, 2020 [12]	Effect of blood-flow restricted vs heavy-load strength training on muscle strength: Systematic review and meta-analysis	-	strength of muscle	A comprehensive analysis and meta-analysis	The meta-analysis suggests that LL-BFR training and high-load strength training are equally effective in enhancing maximal muscle strength in healthy adults, making it a viable alternative or supplement to conventional heavy-load resistance exercise.
9.	Simon Gavanda et al,2020 [13]	Low-intensity blood flow restriction calf muscle training leads to similar functional and structural adaptations than conventional lowload strength training: A randomized controlled trial	6 weeks	Pain, muscle strength, muscle mass.	A randomized controlled trial	The conclusion of the study showed that while LS and CV did not change, BFR calf training enhanced 1-RM and MT in guys trained in RT. Both groups pain VAS scores were comparable. Because BFR calf training takes less time to complete a session until concentric muscle failure, it is therefore preferable to No BFRT.
10.	Breanne S. Baker PhD et al, 2020 [14]	Does Blood Flow Restriction Therapy in Patients Older Than Age 50 Result in Muscle Hypertrophy, Increased Strength, or Greater Physical Function? A Systematic Review		Muscle strength, muscle hypertrophy	A Systematic Review and Meta-Analyses	The evidence suggests that BFR can stimulate muscle hypertrophy, thereby enhancing strength of muscles and athletic abilities in the elderly.
11.	Luke Hughes et al, 2019 [15]	Comparing the Effectiveness of Blood Flow Restriction and Traditional Heavy Load Resistance Training in the Post-Surgery Rehabilitation of Anterior Cruciate Ligament Reconstruction Patients: A UK National Health Service Randomised Controlled Trial	8 weeks	Muscle strength, pain, ROM,	A randomized control trial	As stated by the BFR-RT can lessen knee joint discomfort, increase skeletal muscle growth and strength, and effusion, and enhance overall physical function, making it more suitable for progressive limb loading in NHS ACLR patient populations.

12.	Ashley B. Anderson, MD et al, 2019 [16]	Blood Flow Restriction Therapy: From Development to Applications	6 weeks	Muscle strength	Review of literature	BFR training, supplemented with routine resistance, may enhance strength and muscle hypertrophy in military servicemen. It's suitable for patients' post-surgery or those unable to perform higher exertion levels, offering a potential rehabilitation augmentation method.
13.	Sue Barber-Westin, et al, 2019 [17]	Blood Flow-Restricted Training for Lower Extremity Muscle Weakness due to Knee Pathology: A Systematic Review	-	Muscle strength	Systematic Review	This thorough investigation showed that BFRT may improve quadriceps strength in knee-related weakness and atrophy patients. Short-duration vascular occlusion and low-load resistance exercises are safe after surgery or arthritic knees.
14.	Rubens Vinícius Letieri et al, 2018 [18]	Effect of 16 weeks of resistance exercise and detraining comparing two methods of blood flow restriction in muscle strength of healthy older women: A randomized controlled trial	6 weeks	Muscle strength	A study that is controlled and randomized	BFR and resistance exercise in elderly women increase muscle strength levels, similar to high-intensity interval training (HI) without occlusion. Muscle strength gains are well preserved after six weeks of detraining, possibly due to neural adaptations. BFR methods are effective elder females, individuals with long-term disabilities, and post-surgical rehabilitation, the way they are low-cost and well-tolerated alternatives to traditional exercise.
15.	Rodrigo Branco Ferraz et al, 2018 [19]	Benefits of Resistance Training with Blood Flow Restriction in Knee Osteoarthritis	12 weeks	Muscle strength, muscle mass, pain	A randomized control trial	The study found that BFRT and HI-RT improved muscle strength, quadriceps muscle mass, and functionality in older female knee OA patients, while also improving pain and reducing joint stress, making BFRT a viable therapeutic adjuvant.
16.	Luke Hughes et al, 2017 [20]	Blood flow restriction training in clinical musculoskeletal rehabilitation: a systematic review and meta-analysis	-	Muscle strength, size, and mass	A comprehensive evaluation and meta-analysis	This review showed the significance of strength training in MSK rehabilitation, demonstrating that LL-BFR training offers a more effective and tolerable approach to low-load and heavy-load rehabilitation, with individualized prescriptions potentially reducing pain.

17.	Joshua Slysz Jack Stultz Jamie F. Burr et al, 2015 [1]	The efficacy of blood flow restricted exercise: A systematic review and meta-analysis	-	Muscle strength, muscle size	comprehensive evaluation and meta-analysis	This study demonstrated that exercise, when paired with BFR, increases muscle growth and strength. more than just low-load exercise. This suggests that BFR significantly contributes to adaptive processes, offering potential benefits to various practitioners, including individuals healing from orthopedic conditions and athletes. It also helps in progressing strength while lowering the weights on associated tissues.
18.	Christopher A. Fahs et al, 2015 [21]	Muscular adaptations to fatiguing exercise with and without blood flow restriction	6 weeks	Muscular strength, muscular power, muscle endurance	Experimental study	The study suggests low-load resistance training, BFR or not, can increase muscular mass and endurance in middle-aged individuals. It suggests that total exercise volume is crucial for muscle adaptation, and low-muscular strength individuals may see the greatest strength adaptation.
19.	Stephen D. Patterson et al, 2011 [22]	Enhancing Strength and Post occlusive Calf Blood Flow in Older People With Training with Blood-Flow Restriction	4 weeks	Muscle strength	Experimental study	Research shows that a 4-week training intervention combining BFR and LLRT can dramatically boost power and blood-flow parameters in older adults.
20.	Stephen D. Patterson et al, 2010 [23]	Increase in calf post-occlusive blood flow and strength following short-term resistance exercise training with blood flow restriction in young women	4 weeks	Muscle strength	Experimental study	The study found that resistance exercise utilizing BFR increased peak post-occlusive blood pressure and power parameters, including maximal dynamic strength, maximal voluntary contraction, and isokinetic strength, compared to training without limitation of blood flow. This suggests that Blood flow limitation in LLRT is more effective.

**DISCUSSION**

This research attempted to evaluate BFRT’s impact. to reduce pain and increase muscle strength. BFR training significantly improves strength of muscle over weeks, particularly in long jumpers. Combining low-intensity BFR with high-intensity resistance training enhances isometric, dynamic, and isokinetic strength, promoting muscle mass and strength. According to some research, eccentric exercise coupled with high restrictive forces can cause DOMS, lengthen the healing period, and encourage muscle mass and growth. Applying BFR after exercise could prevent DOMS more effectively. BFR’s effects on DOMS, however, is still debatable; some research indicates pro-inflammatory effects, while others show anti-inflammatory benefits. some article suggests that, Patellar instability is a complex condition affecting the lower extremity, affecting quadriceps and hip strength. This trial aims to evaluate if combining standard physical therapy with BFRT significantly improves patient outcomes, function, and joint health over the initial two years of recovery. According to

certain articles, BFR training helps patients with knee problems feel less discomfort and build more muscle. A meta-analysis showed that both L-BFR and H-RT improved patients' strength of muscles after knee injuries. However, L-BFR training had a lower pain score and more muscle strength. BFR training is linked to decrease blood flow, venous blood aggregation, and increased expression of insulin-like growth factor-1, leading to muscle growth and strength. L-BFR training is a desirable rehabilitation technique for the restoration of muscular strength as it is more successful in raising pain scores and lowering pain sensitivity. According to certain research, BFR training is just as effective as high intensity training (HI-TR) in helping people with knee osteoarthritis (KOA) increase their muscle strength. However, the results conflicted on the effect of BFR-TR compared to other intensities. BFR technique is popular for its potential to achieve strength and performance gains with lower resistance levels. It can be included into high-level athletes' training regimens or utilised in patients' rehabilitation after surgery who can't bear weight or engage in much activity. Larger muscles, sports performance metrics, as well as muscular strength can all be significantly increased with BFR training. But there is variability in frequency, durations, and protocols, making it challenging to determine which sports and athletes can benefit most from BFR training. Some study showed that Occlusive training significantly increase strength of muscles and pain intensity in people who have ACL reconstruction or knee OA, according a systematic evaluation of ten RCTs. The study also revealed that quadriceps weakness persists post-surgery, emphasizing the need for rehabilitation. Despite differences in training regimens, the BFR group outperformed the high-load group of control in terms of performance. Some study explores the consequences of BFR pressures on strength in the muscles in older women, finding that resistance training that combines BFR and LI exercise increases strength, maintains it, and prevents decline to baseline values.

#### CONCLUSION:

However, after conducting this study BFR technique (BFRT) was found effective in reducing pain and improve muscle strength in various conditions like Long Jumpers, DOMS, Knee Injury, OA Knee, Patellar Instability, Athletes, ACL Reconstructions, Older Women, Muscle weakness. These results highlight BFRT's adaptability and potential use as a performance-enhancing and rehabilitative technique across a range of demographics and situations. The extensive applicability of BFRT in enhancing musculoskeletal health and function across many populations and clinical circumstances is supported by the study's substantial amount of data.

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