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Khairul Islam
Assistant Professor, Department of Physiotherapy, School of Allied Health, Swami Vivekananda University, West Bengal, India

Corresponding Author:
Khairul Islam
Assistant Professor, Department of Physiotherapy, School of Allied Health, Swami Vivekananda University, West Bengal, India

The impact of blood flow restriction training on lateral epicondylitis grip strength and disability

Khairul Islam

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Abstract

Background: Tennis elbow, also known as lateral epicondylitis, is a common ailment marked by pain and diminished grip strength. Because traditional rehabilitation techniques can produce variable outcomes, other treatments such as Blood Flow Restriction (BFR) training are being investigated. BFR aims to improve muscle strength and function by limiting blood flow during low-load activities.
Objective: This case study assesses the impact of BFR training in improving grip strength and reducing disability in a patient with lateral epicondylitis.
Methods: Low-load resistance exercises that targeted the forearm muscles were part of a 6-week BFR training program for a patient with lateral epicondylitis. A dynamometer was used to test grip strength, and the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire was used to assess disability both before and after the intervention.
Results: Significant functional improvement and pain reduction were demonstrated by the patient, who demonstrated a 25% gain in grip strength and a 40% decrease in impairment based on DASH ratings.
Conclusion: In order to improve grip strength and lessen handicap in lateral epicondylitis, BFR training might be a useful supplement to traditional therapy. To validate these findings in broader populations, more research is required.

Keywords: Lateral epicondylitis, tennis elbow, blood flow restriction training, grip strength, disability, rehabilitation

1. Introduction
1.1. Background and Rationale
One of the most frequent tendinopathies affecting the elbow is lateral epicondylitis (LE), sometimes known as "tennis elbow," which is characterized by discomfort and dysfunction that is largely localized to the lateral epicondyle of the humerus. Despite being commonly linked to tennis players, anyone who performs repetitive gripping, wrist extension, and forearm supination movements may develop the illness. This syndrome can be exacerbated by a variety of activities, including physical labor, typing, and racquet sports (Vicenzino *et al.*, 2020) [3].

1.2 Prevalence and Risk Factors
Every year, between 1% and 3% of people are thought to get lateral epicondylitis, especially those in their 30s to 50s. The syndrome is most prevalent in populations where the extensors of the wrist and forearm, particularly the extensor carpi radialis brevis (ECRB) muscle, are subjected to repetitive stress. Carpenters, painters, and computer users are among the occupations that have a high risk of developing lateral epicondylitis because they need repetitive wrist extension and gripping (Sanders *et al.*, 2015). Even though racquet sports are frequently linked to this ailment, only a small percentage of instances are truly related to tennis players, indicating that the condition is common across a wide range of activities and demographics.

1.3 Pathophysiology
At first, lateral epicondylitis was believed to be an inflammatory disease because of its discomfort and swelling.

It is more appropriately categorized as a degenerative tendinopathy than an acute inflammatory condition, nevertheless, as recent studies have shown. Microtears in the ECRB tendon are the underlying disease, and they cause inadequate healing responses as a result of repeated stress and pressure. This leads to angiofibroblastic hyperplasia, which is characterized by vascular infiltration, disordered tendon fibers, and the buildup of immature collagen (Alfredson & Lorentzon, 2016) [1].

The prolonged occurrence of symptoms in patients with lateral epicondylitis is frequently explained by the shift from an acute inflammatory state to a chronic degenerative phase. Tendon degeneration may eventually lead to tendon thickness, which would further impair the tendon's mechanical characteristics and capacity to support weight. The forearm muscles and tendons gradually weaken as a result of this cycle of microtrauma, unsuccessful healing, and tendon degeneration, which causes pain, diminished grip strength, and a reduction in functional ability (Ciccotti *et al*., 2014) [10].

Symptoms and Clinical Presentation

The lateral aspect of the elbow is usually where patients with lateral epicondylitis report with pain, which is frequently made worse by grasping, forearm supination, or wrist extension. In extreme situations, the discomfort may travel up toward the upper arm or down the forearm, impairing one's ability to perform daily tasks. According to Gosens *et al*. (2011) [4], a clinical examination typically shows discomfort over the lateral epicondyle, a positive Mill's test (passive wrist flexion with the elbow extended), and a positive Cozen's test (resisted wrist extension with the elbow in full extension).

Additionally, patients may have weaker grips, which makes it much more difficult for them to carry out duties involving lifting or grasping objects. One of the main functional limitations linked to lateral epicondylitis is a loss of grip strength, which can significantly impair a person's capacity to work or partake in leisure activities (Park *et al*., 2013).

1.4 Traditional Treatment Approaches for Lateral Epicondylitis

Because of its high recurrence rates and varied responsiveness to rehabilitation, lateral epicondylitis is still difficult to cure despite its great prevalence. From more intrusive surgical procedures to conservative physical therapy, a broad range of therapies have been suggested.

Conservative Treatment Approaches

In order to reduce symptoms, encourage tendon repair, and restore function, conservative therapy approaches are typically the first line of treatments for lateral epicondylitis. Rest, physical therapy, eccentric exercise regimens, anti-inflammatory drugs, and the use of orthotic devices such wrist splints are examples of common conservative therapies (Malliaras *et al*., 2013) [7].

Eccentric Strengthening Exercises

Numerous studies have shown that eccentric exercises are effective in reducing pain and improving grip strength in patients with tendinopathies (Tyler *et al*., 2010) [16]. However, some patients report increased pain during the initial phases of eccentric training, which may limit adherence to the exercise regimen. Eccentric strengthening exercises comprise lengthening the muscle while it is under tension, which is thought to promote tendon healing and remodeling.

Physical Therapy Modalities

Exercise-based rehabilitation is frequently supplemented with physical therapy techniques like electrical stimulation, soft tissue manipulation, and ultrasound therapy. These techniques seek to enhance circulation, lessen discomfort, and encourage tissue repair. The effectiveness of these therapies is still up for debate, though, as some research has found only slight improvements in function and discomfort (Bisset *et al*., 2006) [2].

Corticosteroid Injections

Corticosteroid injections are commonly used to manage pain and inflammation in patients with lateral epicondylitis, particularly those who do not respond to conservative treatments. While corticosteroids may provide short-term pain relief, their long-term efficacy is questionable. A systematic review by Coombes *et al*. (2015) [3] found that although corticosteroid injections can reduce pain in the short term, they may actually be associated with poorer outcomes over the long term, with higher recurrence rates and diminished tendon healing (Coombes, Bisset, & Vicenzino, 2015) [3].

Surgical Intervention:

Surgical intervention is typically reserved for patients with chronic lateral epicondylitis who fail to respond to conservative treatments. Surgical options include debridement of the degenerated tendon, release of the ECRB tendon, and repair of any torn fibers. While surgery may improve symptoms in some cases, it carries the risks associated with invasive procedures, such as infection, nerve damage, and prolonged recovery time. Furthermore, surgery does not guarantee a complete resolution of symptoms, and recurrence remains a possibility (Kroslak & Murrell, 2018) [6].

1.5 Limitations of Traditional Treatments

Despite the variety of available treatment options, many patients with lateral epicondylitis experience incomplete recovery or recurrence of symptoms. Conservative treatments, while often successful in the short term, may not address the underlying degenerative changes in the tendon, leading to chronic pain and dysfunction. Moreover, the side effects and limitations of corticosteroid injections and surgical interventions underscore the need for alternative treatment strategies that can provide more durable improvements in both pain and function (Mishra *et al*., 2014).

Studies on the long-term effectiveness of traditional treatments for lateral epicondylitis have yielded mixed results. For instance, a study by Smidt *et al*. (2002) reported that many patients who received corticosteroid injections or underwent physical therapy still experienced symptoms after one year, with only marginal improvements in functional outcomes (Smidt *et al*., 2002). This finding highlights the need for innovative rehabilitation strategies that not only alleviate symptoms but also address the structural deficits in the tendon and musculature.

1.6 Emergence of Blood Flow Restriction (BFR) Training
In light of the limitations of traditional treatment methods, Blood Flow Restriction (BFR) training has gained considerable attention as a potential adjunctive therapy for musculoskeletal conditions, including lateral epicondylitis. Originally developed as a training technique for athletes, BFR involves the application of a tourniquet or cuff to restrict venous blood flow from the exercising limb while maintaining arterial inflow. This partial occlusion creates a hypoxic environment in the muscle, which is thought to stimulate hypertrophic and strength adaptations similar to those observed with high-load resistance training, but at significantly lower mechanical loads (Hughes *et al*., 2017) [5].

Physiological Mechanisms of BFR Training

Although the exact physiological mechanisms by which BFR exercise encourages muscular hypertrophy and strength improvements are unknown, it is thought that a number of elements are involved. First, a series of anabolic signaling pathways, including the upregulation of growth hormone and insulin-like growth factor 1 (IGF-1), which are both essential for muscle growth and repair, are triggered by the buildup of metabolic byproducts, such as lactate, brought on by restricted venous outflow (Pearson & Hussain, 2015) [12].

Second, the hypoxic environment created by BFR training promotes the recruitment of fast-twitch muscle fibers, which are typically activated only during high-load resistance exercises. This recruitment of fast-twitch fibers contributes to muscle hypertrophy and strength gains, even when low-load exercises are performed (Scott *et al*., 2015) [13]. Additionally, BFR training has been shown to increase muscle protein synthesis rates, thereby enhancing muscle recovery and repair.

Applications of BFR in Tendon Rehabilitation

Recent studies have examined the possible advantages of BFR training for tendon health and rehabilitation, however the majority of the study has been on its application in improving muscle strength and hypertrophy. Similar to muscles, tendon remodeling and collagen synthesis are triggered in response to mechanical strain. Patients with tendon injuries, like lateral epicondylitis, can perform rehabilitative exercises that encourage tendon healing without exposing the tendon to significant mechanical loads that could worsen the injury by using BFR during low-load resistance exercises (Patterson *et al*., 2019) [8].

Given that it minimizes the chance of more tendon damage while restoring muscle strength and function, BFR training may be a novel therapeutic method for patients with lateral epicondylitis. Furthermore, because BFR exercises are low-load, they are a desirable alternative for patients who cannot endure high-load resistance training because of discomfort or functional restrictions.

1.7 Objective
This case study's main goal is to evaluate how well a 6-week BFR training program works to increase grip strength and lessen impairment in a patient with lateral epicondylitis. Evaluating the effect of BFR on pain management and general functional enhancements are secondary goals.

2. Case Presentation
2.1. Patient History
The patient, a 34-year-old male, presented with a 9-month history of persistent lateral elbow pain, diagnosed as lateral epicondylitis. The patient reported a gradual onset of symptoms following an increase in occupational tasks involving repetitive wrist extension and forearm supination. Initial treatments included non-steroidal anti-inflammatory drugs (NSAIDs) and physiotherapy, which provided temporary relief. However, symptoms persisted, and the patient continued to experience difficulty with tasks requiring grip strength, such as holding tools and performing overhead work. The patient expressed frustration with the limited improvement from conventional rehabilitation methods and sought alternative treatment options.

2.2. Physical Examination
On examination, the patient exhibited tenderness over the lateral epicondyle, with a positive Cozen's test and Mill's test, both indicative of lateral epicondylitis. Grip strength in the affected arm was 22 kg, measured using a hand dynamometer. Pain intensity was rated as 6/10 on the Visual Analog Scale (VAS) during activities involving wrist extension. The patient's DASH score was 55, reflecting moderate disability in performing tasks involving the upper limb.

3. Methods
3.1. Intervention
The patient was enrolled in a 6-week Blood Flow Restriction (BFR) training program designed to target the forearm extensor muscles. The program was conducted under the supervision of a certified physiotherapist trained in BFR application. The intervention involved low-load resistance exercises performed three times per week. Each session lasted approximately 30 minutes and included the following components:

1. **BFR Application:** A pneumatic cuff was applied to the upper arm of the affected limb, inflated to 50% of the patient's arterial occlusion pressure. The cuff remained inflated throughout the exercise session.
2. **Exercise Protocol:**

- **Wrist Extension with Resistance Band:** Performed with low resistance (20% of the patient's one-repetition maximum), 3 sets of 15-20 repetitions.
- **Forearm Supination with Resistance Band:** 3 sets of 15-20 repetitions.
- **Isometric Grip Squeezes:** Performed using a soft stress ball, 3 sets of 10-second holds, repeated 10 times.

3. **Rest Intervals:** A 30-second rest was provided between sets, with the cuff remaining inflated throughout the rest period to maintain blood flow restriction.

3.2. Outcome Measures
The primary outcomes were grip strength and functional disability, measured at baseline and post-intervention.

1. **Grip Strength:** Measured using a hand-held dynamometer (Jamar, Sammons Preston, Inc.) with the elbow in 90 degrees of flexion. The average of three trials was recorded as the patient's grip strength.
2. **Disabilities of the Arm, Shoulder, and Hand (DASH) Questionnaire:** A 30-item questionnaire assessing the

patient's ability to perform activities of daily living involving the upper limb. Scores range from 0 to 100, with higher scores indicating greater disability.

3. **Visual Analog Scale (VAS):** Pain intensity was rated by the patient during wrist extension activities. The VAS is a 10 cm scale where 0 represents no pain, and 10 represents the worst possible pain.

4. Results

4.1. Grip Strength

The patient showed a notable increase in grip strength at the end of the 6-week BFR training program, going from 22 kg at baseline to 27.5 kg, or a 25% increase. All three trials showed the same improvement, suggesting that the forearm extensor muscles had grown stronger and more resilient.

4.2. DASH Score

After the intervention, the patient's DASH score dropped from 55 at baseline to 33, indicating a 40% decrease in disability. This noticeable improvement suggested that the patient had less trouble carrying out everyday duties, especially those that required forearm and grip function. The patient claimed that he or she was able to resume work with little difficulty and that using tools and lifting objects were painless.

4.3. Pain Reduction

Pain intensity, as measured by the VAS, decreased from 6/10 at baseline to 2/10 post-intervention. The patient reported a substantial reduction in pain during activities involving wrist extension and gripping, which contributed to the overall improvement in function and quality of life.

5. Discussion

5.1. Mechanisms of BFR Training

The suggested processes by which BFR training improves muscular strength and function are in line with the notable improvements seen in this case study. Through a number of mechanisms, BFR training causes metabolic stress and encourages muscular growth when paired with low-load resistance workouts. Restricting venous return creates a hypoxic environment that promotes the buildup of metabolic byproducts like lactate, which are believed to trigger mechanisms related to muscle growth and repair (Slysz *et al*., 2016) [13]. According to Pearson and Hussain (2015) [12], this rise in metabolic stress is thought to promote the recruitment of fast-twitch muscle fibers, which are normally recruited during high-load resistance training, and upregulate growth factors including insulin-like growth factor 1 (IGF-1).

In the context of lateral epicondylitis, BFR training may also enhance tendon healing by promoting the production of collagen and improving blood flow to the injured tendon. The low mechanical load used in BFR exercises reduces the risk of further tendon damage, making it an ideal intervention for patients with chronic tendon injuries, such as lateral epicondylitis (Patterson *et al*., 2019) [8].

5.2. Comparison with Traditional Rehabilitation Approaches

Eccentric exercises and other conventional rehabilitation methods for lateral epicondylitis have shown varying degrees of efficacy in strengthening grips and easing discomfort. Because eccentric loading places large mechanical pressures on the injured tendon, it can worsen symptoms in the early phases of rehabilitation even though it has been demonstrated to induce tendon remodeling (Coombes, Bisset, & Vicenzino, 2015) [3]. BFR training, on the other hand, offers a lower-load substitute that nevertheless encourages strength and muscular growth without the risk of tendon overload.

The results of research using conventional rehabilitation techniques are in good agreement with the 25% increase in grip strength seen in this case study. According to Tyler *et al*. (2010) [16], for instance, patients with lateral epicondylitis who participated in a 6-week eccentric training program showed a 20% increase in grip strength. The fact that many patients reported more pain in the beginning of the program, however, suggests that BFR training may be beneficial in reducing discomfort while producing strength gains that are comparable to or even greater.

5.3. Pain Reduction and Functional Improvement

One of the case study's most noteworthy findings is the 40% decrease in disability, as measured by the DASH score. Significant functional limits are frequently caused by lateral epicondylitis, especially when doing gripping or lifting jobs. Given the patient's notable improvement in DASH scores, it appears that BFR training not only increases muscle strength but also produces noticeable functional improvements in day-to-day tasks.

Further demonstrating the effectiveness of BFR training in treating lateral epicondylitis symptoms is the patient's decreased discomfort, as shown by the drop in VAS ratings from 6/10 to 2/10. Successful rehabilitation requires the ability to both improve function and reduce pain, especially for individuals with chronic diseases where pain can be a persistent obstacle to recovery.

5.4. Limitations and Future Research

Although this case study's findings are promising, it is important to recognize a number of its shortcomings. First, the results might not apply to the larger community of people with lateral epicondylitis because of the single-subject approach. The favorable results in this case study might have been influenced by the patient's relative youth and level of physical activity. Furthermore, the absence of a control group in the study made it challenging to attribute the benefits exclusively to BFR training.

In order to ascertain the effectiveness of BFR training in a more varied population, future studies should attempt to overcome these constraints by carrying out randomized controlled trials (RCTs) with bigger sample sizes. These investigations ought to look into how BFR training affects tendon health and function over the long run, as well as if BFR can help people with chronic lateral epicondylitis avoid reoccurring symptoms.

6. Conclusion

The potential of Blood Flow Restriction (BFR) training as a useful supplement to traditional therapy for enhancing grip strength and lowering disability in a patient with lateral epicondylitis is demonstrated in this case study. BFR training may be a good substitute for conventional rehabilitation methods, especially for patients who have not responded to standard therapies, as seen by the case's notable pain reduction, 40% reduction in handicap, and 25% gain in grip strength. To validate these results and investigate the wider uses of BFR training in the treatment of lateral epicondylitis and other musculoskeletal disorders, more investigation is necessary.

7. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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