



Blood Flow Restriction Therapy Effects on Function and Pain in Adults with Lower Leg Pathology

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Objectives

1. By the end of this presentation, listeners will understand the concept of Blood Flow Restriction Therapy (BFRT) and its beneficial use on lower leg pathologies.
2. By the end of this presentation, listeners will have an appreciation for the treatment parameters of BFRT and how to initiate this treatment for future patients.



Overview

Background

Purpose

Materials and Methods

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OCEBM Level Scores

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Acknowledgements



Background

BFRT is a relatively new intervention that is not fully understood. The theory is that BFRT limits the delivery of blood to and from exercising muscles using a tourniquet cuff, which may enhance training adaptations in muscle strength, endurance, and hypertrophy to the damaged muscle caused by injury or surgery.¹



Background Continued

Benefits/Indications include:

Increased muscle endurance

Patients with low exercise tolerance

Contraindications include:

Venous thromboembolism

Cancer

Open fracture

Increased ICP

Lymphectomies

Increased muscle strength

Increased muscle hypertrophy

Sickle cell anemia

Acidosis

Severe hypertension

Severe crush injuries

Extremity infection



Background Continued

Previous studies examine the beneficial use of BFRT following surgical procedures such as ACL repair, hip replacements, rotator cuff surgery, and a myriad of other musculoskeletal pathologies; however, there is no current systematic review on the beneficial use of BFRT with lower leg pathologies.



Purpose

The purpose of this systematic review is to synthesize current literature to determine if BFRT is a safe and effective intervention to decrease pain and improve function in individuals with lower leg pathologies.



Materials/Methods

A literature search (2011-2021) was conducted using Cinahl/EBSCOhost, Google Scholar, PEDro, ProQuest, and PubMed databases with search terms:

(Blood flow restriction OR KAATSU OR vascular occlusion OR BFR) AND (Lower leg pathologies OR injuries OR post-surgical) AND (Physical therapy OR training OR rehabilitation OR recovery OR interventions OR strengthening) AND (Effects OR benefits).



Materials/Methods

Search limits: English language, human subjects, and peer-reviewed.

Selection criteria: Adults ≥ 18 years with impairment and decreased function in the lower leg (distal to the knee), male or female, interventions that included BFRT using the Delfi system, bands, or pressure cuffs in any setting available.

Exclusion criteria: Neurological conditions, pathology unrelated to the lower leg, and vascular studies unrelated to BFRT



Search Results

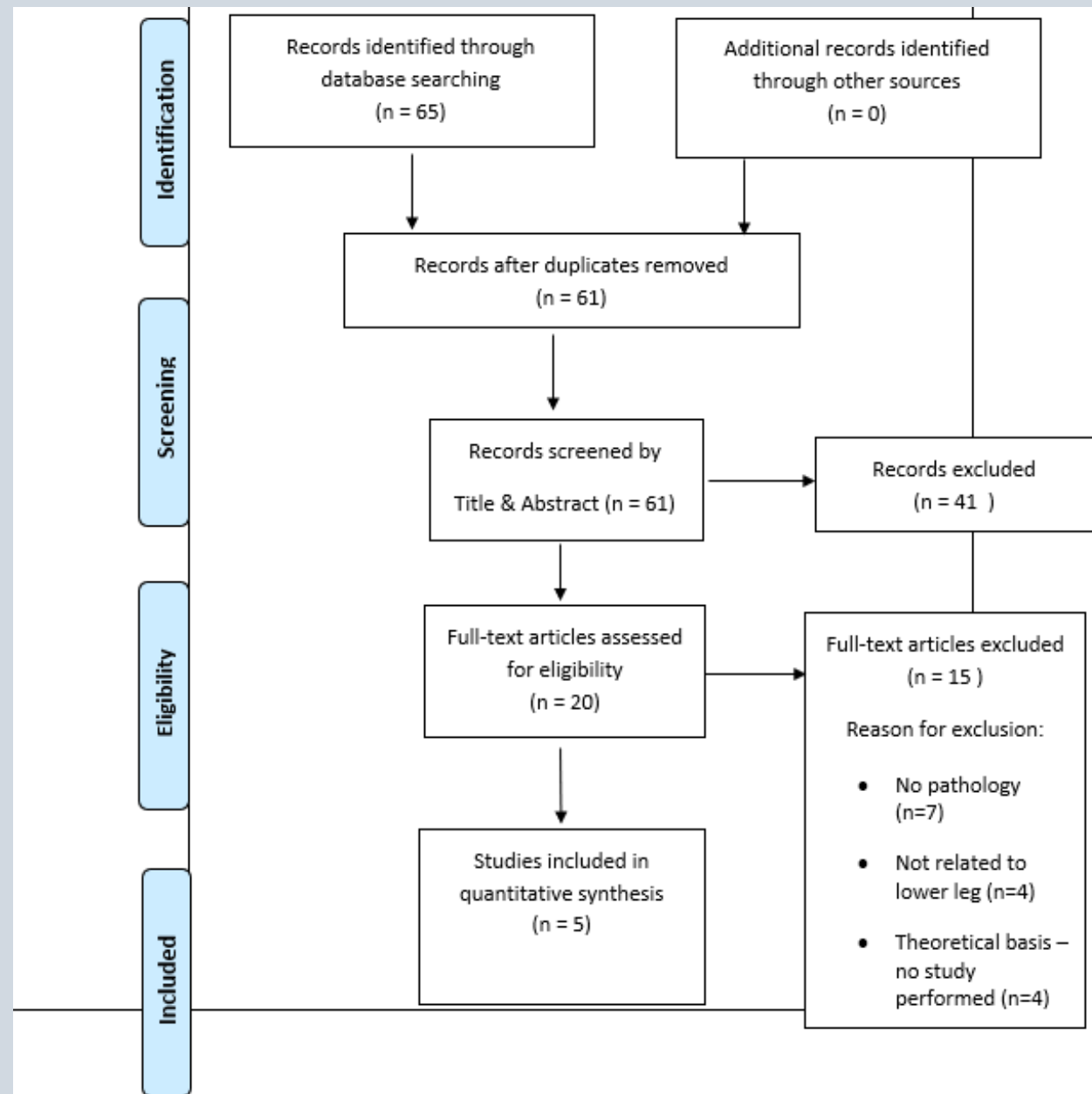
Sixty-five articles were assessed for eligibility.

After appraisal, 5 studies met our selection criteria including 1 case report, 2 case series, 1 cross-over study design, and 1 single-blinded randomized control trial.

OCEBM levels of evidence ranged from 2-4. Sample sizes ranged from 1-28 (57 total) subjects with lower leg pathology with age of subjects ranging from 19-49 years old.



PRISMA Flow Chart



Scores

Articles	Level Of Evidence	Design	Pathologies	Outcome Measures
Di Lemme et al. (2020)	Level 4	Case Report	Nondisplaced talus fracture	Brief Pain Inventory (BPI), Lower Extremity Functional Scale (LEFS), Leg circumference (cm)
Killinger et al. (2020)	Level 2	Cross over study design	Ankle sprain/instability	Surface EMG muscle activation, SmO ₂ , RPE during exercises
Ladlow et al. (2018)	Level 2	Single-Blind RCT	Ankle injury	Muscle Hypertrophy (CSA and volume measurements), Muscle Strength (5-RM knee extension and leg press test), Isometric hip extension (dynamometer), Endurance (MSLT), Balance (Y-balance test), Pain (VAS)
Hylden et al. (2015)	Level 4	Case Series	Tibial plateau fracture	Average power
Yow et al. (2018)	Level 4	Case Report	Achilles tendon rupture	Power (j/s), Peak torque

Results

Treatment parameters used the Delfi System protocol, 4 sets (30, 15, 15, 15 reps), with rest time ranging from 30-45sec between sets (avg 33 secs).

Four studies utilized the 8-minute protocol at 60-80% of lower limb occlusion.

One study used the Hokanson AG 101 cuff insulator air source, E20 rapid cuff inflator, and cc17 thigh cuff using 4 sets until failure with 30 sec between set rest periods.

Duration ranged from 2 days to 6 weeks.



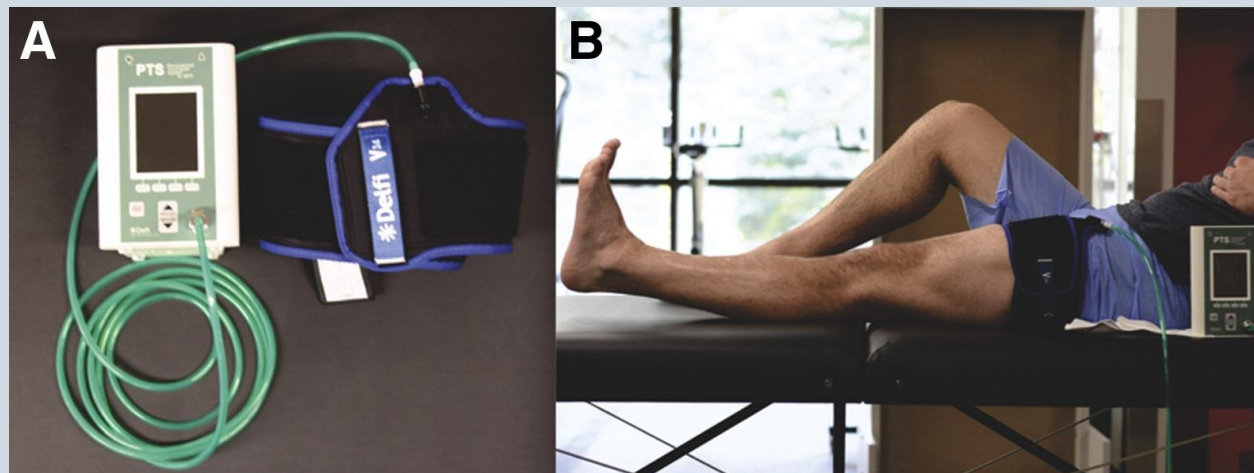
Results

Primary outcome measures for pain and function included:

Visual Analog Scale (VAS)

Brief Pain Inventory (BPI)

Lower Extremity Functional Scale (LEFS)



Results

Two studies^{2,3} (Level 2, $p < 0.01$) showed pain reduction (66 to 19 points on VAS) throughout the intervention and BPI after the intervention (13-0 pts).

One study⁴ (Level 4) found improvement using the Delfi System at 80% of lower limb occlusion on the LEFS at week 5.5 (49 pts) vs week 2 (14 pts).



Key Findings Summary

Articles	Findings
Di Lemme et al. (2020)	BPI pain assessment decreased, LEFS score improved
Killinger et al. (2020)	Surface EMG muscle activation improved, SmO2 decreased, RPE increased
Ladlow et al. (2018)	Muscle hypertrophy increased, muscle strength increased, isometric hip extension increased, muscle endurance increased, balance improved, pain decreased
Hylden et al. (2015)	Average power increased
Yow et al. (2018)	Power and peak torque increased

Study Limitations

Different pathologies and lack of heterogeneous injuries

Different outcome measures used

Short term studies

Small sample sizes

Different protocols and the lack of consistency between the articles' protocols

Lack of control groups



Conclusion

Secondary to numerous limitations, there is low to moderate evidence supporting use of BFRT in adults who have lower leg pathologies to decrease pain and improve function.



Future Research

High-level research with the ideal dosage, training parameters, and adequate follow-up is needed for more conclusive evidence of the substantial benefits of using BFRT with lower leg pathologies.

Other examples of future research may include but are not limited to:

Larger sample sizes

More consistency in pathologies



Clinical Relevance

An innovative therapeutic intervention such as BFRT may be used to decrease pain (VAS MCID=30 mm) with clinically meaningful improvement in function (exceeded LEFS MCID=9 pts.).

Based on evidence, physical therapists should consider the use of BFRT in conjunction with standard interventions as a safe and effective intervention for patients with lower leg injuries.



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References

1. Faltus J, Owens J, Hedt C. Theoretical applications of blood flow restriction training In managing chronic ankle instability in the basketball athlete. *Int J Sports Phys Ther.* 2018;13(3):552-560. doi:10.26603/ijspt20180552
2. Killinger B, Lauver JD, Donovan L, Goetschius J. The effects of blood flow restriction on muscle activation and hypoxia in individuals with chronic ankle instability. *J Sport Rehabil.* 2020;29(5):633-639. doi:10.1123/jsr.2018-0416
3. Ladlow P, Coppack RJ, Dharm-Datta S, et al. Low-load resistance training with blood flow restriction improves clinical outcomes in musculoskeletal rehabilitation: a single-blind randomized controlled trial. *Front Physiol.* 2018; 9. doi:10.3389/fphys.2018.01269
4. Di Lemme S, Sanderson J, Celebrini RG, Dover GC. A comprehensive nonoperative rehabilitation program including blood flow restriction for a talus fracture in a professional hockey player: a case report. *Int J Athl Ther Train.* 2020; 25(3):121-130. doi:10.1123/ijatt.2019-0019
5. Hylden C, Burns T, Stinner D, Owens J. Blood flow restriction rehabilitation for extremity weakness: a case series. *J Spec Oper Med.* 2015; 15(1):50-56 5.
6. Yow BG, Tennent DJ, Dowd TC, Loenneke JP, Owens JG. Blood flow restriction training after achilles tendon rupture. *J Foot Ankle Surg.* 2018; 57(3):635-638. doi:10.1053/j.jfas.2017.11.008



Questions?



Appendix

Blood flow restriction- Applied pressure with the use of a tourniquet, maintaining arterial inflow into the specific muscles during exercise while occluding venous outflow from the muscles distal to the occlusion site.

Goal of BFRT is to enable patient to achieve greater strength while decreasing load which overall reduces the amount stress on the limb.

Pathologies included in the systematic review are multiple Achilles tendon ruptures, nondisplaced talus fracture, chronic ankle instability, ankle inversion injury, tibia plateau fracture, calcaneus and fibula fracture, open tibia and fibula secondary to blast injury, and comminuted left open calcaneus fracture.

