



Personalized Blood Flow Restriction (BFR) Guideline

This rehabilitation program is designed to inform clinicians on the proper usage and implementation for personalized BFR rehab post-operative. It is designed for rehabilitation following shoulder, elbow, hip, knee, and ankle surgeries. In addition, it is designed for use in non-operative musculoskeletal injuries as well. Modifications to this guideline may be necessary dependent on physician specific instruction, concomitant injuries or procedures performed. This guideline is designed to progress the individual through rehabilitation to full sport/activity participation. The therapist may modify the program appropriately depending on the individual's goals for activity.

This guideline is intended to provide the treating clinician a frame of reference for personalized BFR rehabilitation. It is not intended to substitute clinical judgment regarding the patient's post-operative care based on exam/treatment findings, individual progress, and/or the presence of concomitant procedures or post-operative complications. If the clinician should have questions regarding post-operative progression, they should contact the referring physician.

General Guidelines/ Precautions

- Personalized BFR rehab is indicated for patients who cannot perform normal strength and hypertrophy training to an intensity that produces true strength and hypertrophy adaptation due to post-surgical status, irritability of patient's injury, or lack of proper loading equipment in clinic.
 - Normal strength training is characterized as strength training to an intensity of 75% - 85% 1-repetition maximum (1-RM) by the American College of Sports Medicine and National Strength and Conditioning Association
 - BFR exercise is not to replace traditional strength training and is to be used as a supplement to return to traditional strength training.
- BFR rehab can start as early as 1-3 days post-operative for arthroscopic surgeries such as ACL reconstruction where incisions and wounds are small, and the concomitant swelling is reduced.
 - Open surgeries that produce larger scars, increased wound healing time, and increased swelling such as total knee arthroplasties, may require a later start around 2-3 weeks or until sutures or staples are removed.

- BFR exercise can be performed with any strength training exercise that is normally used for rehab or high level strength training when prescribed to the right intensity.
 - The only exercises not performed with BFR exercise are running and plyometrics.
- The intended repetition scheme for BFR exercise is 30-15-15-15 for a total of 75 repetitions for one BFR exercise.
 - If an exercise is more complex or the patient has increased weakness, a rep scheme such as 20-10-10-10 or 4x15 may be more applicable.
- The intensity used for BFR exercise is 20% - 30% 1-RM. This is a rating of perceived exertion (RPE) of 2-3/10.
 - If a percentage of 1-RM is not able to be determined for an exercise, the therapist should default to the failure model.
 - This means to choose an exercise that allows the patient to reach volitional fatigue during the last 5 – 10 reps of the final set of the BFR exercise.
- BFR endurance exercise is performed at an intensity of 20% - 40% of heart rate reserve or VO2 maximum.
 - This correlates to an exercise intensity of 2-4/10 of RPE or an intensity that the patient is still able maintain a conversation at while performing endurance exercise.
- The BFR cuff is NOT deflated between sets but IS deflated between exercises.
- A new limb occlusion pressure (LOP) should be taken prior to EACH BFR session that is not on the same day.
- The cuff should be placed as proximal on the upper limb or lower limb as possible that does not interfere with the range of motion of the exercise.
- A limb protection sleeve must ALWAYS be used under the cuff to decrease friction between the patient's skin and cuff.
 - If the patient is wearing compression shorts or tight leggings, this is acceptable for BFR exercise.
 - Jeans, shorts, sweatpants, or other thick clothing should not be used as a barrier between the cuff and the skin.
- BFR exercise is performed at 80% of LOP in the lower extremity and 50% of LOP in the upper extremity
 - When BFR is poorly tolerated a smaller percentage of the LOP can be used.
- LOP should be taken in supine for both upper and lower extremity BFR exercises.
 - An acceptable alternative is to take the LOP in the position the exercises will be performed and is at the discretion of the clinician.

Arthroscopic Personalized BFR Example (This will be variable based on the precautions of the surgery performed)

<p><u>Phase 0</u></p> <p>Patient Education Phase Pre-Operative Phase</p>	<p><i>Discuss:</i> BFR physiology, indications, and screen patient for precautions and contraindications.</p> <p><i>Pre-Operative:</i> Research has shown that as little as 6 sessions of BFR prior to surgery has improved outcomes for strength and hypertrophy compared to those who do not</p> <p>BFR LE exercise: quad sets, SLR, SL hip abduction, prone hip extension, step ups, step downs, leg press, hamstring curls BFR UE exercise: scaption, flexion, abduction, SL external rotation, banded internal rotation, prone row, Is, Ys, Ts, vertical/horizontal pressing, vertical/horizontal pulling</p>
<p><u>Phase I</u></p> <p>Maximum Protection Phase Weeks 0-3</p>	<p><i>Specific Instruction:</i></p> <ul style="list-style-type: none"> -BFR exercise can begin as early as 1-3 days post-operative or as soon as patient can tolerate BFR cuff -BFR exercise in this phase should focus on OKC isolation exercise to improve muscle activation and at least 1 CKC exercise if WB status allows
<p><u>Phase II</u></p> <p>Early Rehabilitation Phase Weeks 3-6</p>	<p><i>Specific Instruction:</i></p> <ul style="list-style-type: none"> -Continue with BFR exercise that is focused on OKC isolation exercise and progress complexity of CKC exercise if WB status allows
<p><u>Phase III</u></p> <p>Controlled Ambulation and Strengthening Phase Weeks 6-16</p>	<p><i>Specific Instruction:</i></p> <ul style="list-style-type: none"> -BFR exercise can focus more on CKC exercise progressions and isolated OKC exercise should be focused to current deficits -Once patient is comfortable loading to an RPE intensity of 7-8/10 BFR exercise should no longer be the primary focus and traditional strength and hypertrophy training should be performed -BFR exercise can become a supplement at or around 12 weeks post surgical if traditional strength training parameters are being met.

Risks

- Arterial calcification
- Abnormal clotting times
- Diabetes
- Sickle cell trait
- Tumor
- General infection
- Hypertension
- Cardiopulmonary conditions
- Renal compromise
- Clinically significant acid-base imbalance
- Atherosclerotic vessels
- Frequent airplane travel
- Anti-hypertensive medication
- Creatine supplements
- Birth control

Contraindications

- Venous thromboembolism
- Previous history of deep vein thrombosis (DVT)
- Impaired circulation
- Peripheral vascular compromise
- Previous revascularization of the extremity
- Extremities with dialysis access
- Acidosis
- Sickle cell anemia
- Extremity infection
- Tumor distal to the tourniquet
- Medications and supplements known to increase clotting risk
- Open fracture
- Increased intracranial pressure
- Open soft tissue injuries
- Post-traumatic lengthy hand reconstructions
- Severe crushing injuries
- Severe hypertension
- Elbow surgery (where there is concomitant excess swelling)
- Skin graft in which all bleeding points must be readily distinguished
- Secondary or delayed procedures after immobilization
- Vascular grafting
- Lymphectomies
- Cancer
- Active pregnancy

References

- Owens, J. G., Hughes, L., Patterson, S., (2020). Blood Flow Restricted Exercise: Physical Therapy Patient Management Using Current Evidence. *American Physical Therapy Association*, 1-52
- Mason, J. S., Owens, J. G., Brown, W. J. (2018). Blood Flow Restriction Training: Current and Future Applications for the Rehabilitation of Musculoskeletal Injuries. *Techniques in Orthopaedics*, 33(2), 1-66

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