

Blood Flow Restriction (BFR) Training Protocol

1. The athlete completes the pre-screening questionnaire (P. 2).
2. The athlete is evaluated for occlusion training eligibility (P. 3).
3. If eligible, the athlete completes the voluntary consent form with coach's permission (P. 4).
4. The training technique is explained.
5. Calculation of BFR pressure: the administering coach will take the athlete's blood pressure and girth measures.

Blood Pressure (systolic pressure – SBP and diastolic blood pressure – DBP)

A digital blood pressure monitor is used and a minimum of 2 measurements is obtained. The cuff width of the monitor should be similar to that of the cuff to be used whilst undertaking BFR training.

- a. First, the athlete is directed to relax in the supine position for five minutes.
- b. Lower Body: SBP and DBP are measured at the ankle at the position of the posterior tibial artery pulse.
- c. Upper Body: SBP and DBP is measured at the most proximal portion of the arm. Note: if the arm pressures are in the ranges 160-179/95-99 mmHg discussion should occur between the physician and BFR administering coach. If these pressures are greater than 179/99 mmHg, prior medical clearance must be obtained.

Girth Measures

- a. Thigh circumference is measured in centimeters at one-third the distance from the inguinal crease to the top of the patella.
- b. Arm circumference is measured in centimeters at the midpoint between the acromion process and the center of the elbow.

Calculation of BFR pressure

The training pressure is calculated as a percent of arterial occlusion. A BFR pressure equivalent to 50-80% of the pressure required to occlude arterial flow is appropriate during low-load resistance exercise(5).

Arterial Occlusion is calculated from the following formulas (2):

$$\begin{aligned} \text{Lower Body Arterial Occlusion (mmHg)} \\ = 0.912(\text{SBP}) + 0.734(\text{DBP}) + 5.893(\text{Thigh Circumference}) - 220.046 \end{aligned}$$

$$\begin{aligned} \text{Upper Body Arterial Occlusion (mmHg)} \\ = 0.667(\text{SBP}) + 0.399(\text{DBP}) + 1.461(\text{Arm Circumference}) + 17.236 \end{aligned}$$

- a. 50% of estimated occlusion is set as an initial guide for maximum pressure to be used.
- b. Pressures can be adjusted according to athlete's training age, experience with resistance training and subjective feeling whilst under use.

6. The athlete is taught how to put the cuffs on themselves under supervision. The cuffs are applied to the most proximal portion of each arm or leg pending on body part being trained.
7. Initial use prior to commencement of set exercise protocol:
 - a. The athlete will be asked to comment on how the cuffs feel.
 - b. Basic and relevant bilateral exercises will be performed at a sub-training load or body weight to ascertain how it feels under movement.
8. Inflation of the cuff is intermittent and the cuff must be deflated between sets of exercise.

Pre-screening Questionnaire for Occlusion Training

1. Do you have a history of high blood pressure? Yes No
2. Do you have diabetes? Yes No
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3. Do you have a history of deep-vein thrombosis (DVT), hereditary thrombotic tendency or antiphospholipid antibody syndrome? Yes No
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4. Are you currently pregnant? Yes No
-

5. Do you have a history of varicose vein of legs? Yes No
6. Do you have a history of prolonged immobility? Yes No
7. Do you have a history of atrial fibrillation or heart failure? Yes No
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8. Are you greater than 60 years old? Yes No
9. Do you have a body mass index (weight/height²) greater than 30? Yes No
10. Do you have a history of hyperlipidemia? Yes No
11. Do you have a history of malignancy? Yes No
12. Do you have a history of using oral contraceptives or adrenocortical steroids? Yes No
13. Do you have a history of quadriplegia? Yes No
14. Do you have a history of high hemoglobin levels? Yes No
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15. Are you between 40-59 years old? Yes No
16. Are you female? Yes No
17. Do you have a BMI (weight/height²) of 24-30? Yes No
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18. Do you have a personal or family history of clotting disorders (e.g. SLE/Lupus, haemophilia, high platelets, etc.)? Yes No
19. Do you have a history of pulmonary embolus? Yes No
20. Do you smoke? Yes No
21. Are you on any medication? Yes No
22. Do you have a history of injury to your arteries or veins? Yes No
23. Do you have a history of injury to any of your nerves (including back or neck injury)? Yes No
24. Does anyone in your family have diabetes? Yes No
25. Does your current or previous training include resistance training? Yes No
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Name: _____

Date: _____

Signature: _____

Determining Eligibility for Training based on the Pre-screen

Eligibility for participation is based on a point system:

- **Five or more points**, they are not eligible for participation in any occlusion training without explicit medical clearance.
- **Three or four points**, they are eligible for participation in lower body occlusion training without medical clearance, but not upper body occlusion training.
- **Less than three points**, they are eligible for both lower and upper body training.

Points	Eligibility
>4	None
3-4	Lower body only
<3	Lower and upper body

Contra-indications and indications for use based upon pre-screening questionnaire

Questions 1-2. If the athlete answers “yes”, they are not eligible to participate until blood pressure is checked for question 1 and fasting blood glucose is checked for question 2.

Question 1, if blood pressure is 160-179/95-99 mmHg, the athlete must undergo an exercise tolerance test prior to beginning occlusion training.

Question 2, if fasting blood glucose is 140-249 mg/dl, the athlete must undergo an exercise tolerance test prior to beginning occlusion training. If fasting blood glucose is >249 mg/dl, the athlete is not eligible for participation.

Questions 3-4 are worth “5” points. Thus, if an athlete answers “yes” to either of these questions, they are not eligible for participation.

Questions 5-7 are worth “3” points.

Questions 8-14 are worth “2” points. If an athlete answers “yes” to Question 10, they should complete an exercise tolerance test prior to eligibility.

Questions 15-17 are worth “1” point.

Questions 9 and 17 should be confirmed by the evaluator taking weight and height. If the athlete has a BMI >24, they should receive an orthopedic examination prior to eligibility.

Questions 18-25 are not worth any “points”, but are to provide the evaluator with additional information. If the athlete has accumulated “4 points” and has answered “yes” to any of these questions, the evaluator should consider declaring the athlete ineligible and seek medical clearance.

If an athlete has been declared eligible for occlusion training with or without explicit medical clearance, they should complete a voluntary consent form.

Voluntary Consent Form for Occlusion Training

Coaching Team

Sport Coach: _____	S&C Coach: _____
Signature: _____	Signature: _____
Email: _____	Email: _____
Phone: _____	Phone: _____

Description and Participation

Occlusion training involves exercising while restricting blood flow with the use of a controlled occlusion cuff around the arms or legs. Participation in occlusion training involves completing a pre-screening questionnaire, assessment for eligibility by a qualified strength and conditioning coach, informed voluntary consent to train in this manner, and physical assessment (blood pressure and girth measurements) to determine the appropriate pressure for the occlusion cuffs. Training sessions will include wearing the occlusion cuffs at an intermittent pressure that restricts up to 50-80% of estimated arterial blood flow and exercising at loads of 20-85% of your one-repetition maximum for up to 30 repetitions. The pressure must be released between sets of exercise. Your participation in this type of training is confidential and will not be revealed to anyone without your expressed permission.

Expected Benefits and Risks

It is expected that this training will benefit you. According to research, it may benefit by causing improvements in power, strength, muscular endurance, hypertrophy, hormonal response and bone health(1,3). There are some risks associated with your participation in this training including subcutaneous hemorrhage (13.1%), temporary numbness (1.3%), venous thrombosis (0.055%), deterioration of ischemic heart disease (0.016%), cerebral infarction (0.008%), rhabdomyolysis (0.008%) and pulmonary embolism (0.008%)(4). The risks are low given your elite athletic status. Additionally, safety and medical procedures and plans are in place to keep these risks to a minimum.

Questions / Further Information / Concerns / Complaints

If you have concerns or require further information, please contact the coaching team above. QAS is committed to training integrity and ethical conduct of training. However, if you have any concerns or complaints about the ethical conduct of the training, you may contact the coaching team above.

Statement of Consent

We ask you to sign this form to confirm your agreement to participate. By signing, you are indicating:

- | | | |
|------------------------------|-----------------------------|--|
| <input type="checkbox"/> Yes | <input type="checkbox"/> No | I have read and understood the information document regarding this training. |
| <input type="checkbox"/> Yes | <input type="checkbox"/> No | I have had any questions answered to my satisfaction. |
| <input type="checkbox"/> Yes | <input type="checkbox"/> No | I understand that if I have any additional questions, I can contact the coaching team. |
| <input type="checkbox"/> Yes | <input type="checkbox"/> No | I understand that I am free to withdraw at any time without comment or penalty. |
| <input type="checkbox"/> Yes | <input type="checkbox"/> No | I understand I can contact the coaching team if I have concerns about the training. |
| <input type="checkbox"/> Yes | <input type="checkbox"/> No | I agree to participate in the training. |

Name: _____

Signature: _____

Date: _____

Email: _____

Implementation

Blood flow restriction can be implemented for several different outcomes. The three primary areas of utilization are for injury management, strength training and competition. A summary table is provided at the bottom of the page.

Injury Management

Occlusion training can be used post-operatively to attenuate atrophy. The training should be implemented passively with and without activation exercises. It can also be used during warm-up for activation on stationary aerobic equipment. Occlusion training can be implemented for injured athletes' strength training (activation, hypertrophy and strength outcomes) because it can be effectively applied to rehabilitative and low-level strength exercise as per appropriate guidelines.

Additionally, occlusion training can be implemented for the prevention of bone stress injury and/or accelerated recovery due to the improved bone response. It would be implemented during normal strength training exercises regimes.

Strength Training

Blood flow restriction can be used during general warm-up for activation and hormonal priming. The warm-up would be conducted on stationary aerobic equipment or with low-level activation based exercises. It could also be used during specific warm-up leading into the main working set and during the main session. This will result in greater activation, hormonal priming, strength and hypertrophy (if applicable). For this use, occlusion training would be implemented primarily in lower body strength exercised (double and single leg) performed with a controlled tempo.

Competition

Some forms of occlusion training can be used during the warm-up prior to competition in order to elicit greater activation and hormonal priming. In this instance, blood flow restriction would be implemented passively or actively through using select exercises at low and moderate intensity within a structured routine.

	When	Why	How
Injury	Post-operative	Atrophy attenuation	Passively / with activation exercises
	Warm-up	Activation	Stationary aerobic equipment
	Strength exercises	Activation, Hypertrophy, Strength	Rehabilitative-based and low-level strength exercises as per appropriate progression
	Bone stress injury	Improve bone response	Normal strength training regimes
Strength Training	Warm-up (general)	Activation Hormonal Priming	Stationary aerobic equipment Low-level activation exercises
	Warm-up (leading into main set) Main session	Activation Hormonal Priming Strength Hypertrophy	Primarily lower body strength exercises (double and single leg) – performed with a controlled tempo.
	Competition	Warm-up	Activation Hormonal Priming

Reference:

1. Beaven, C.M., Gill, N.D., and Cook, C.J. Salivary testosterone and cortisol responses in professional rugby players after four resistance exercise protocols. **Journal Of Strength And Conditioning Research / National Strength & Conditioning Association**. 22: 426–32, 2008.
2. Loenneke, J.P., Allen, K.M., Mouser, J.G., Thiebaud, R.S., Kim, D., Abe, T., et al. Blood flow restriction in the upper and lower limbs is predicted by limb circumference and systolic blood pressure. **European Journal Of Applied Physiology**. 115: 397–405, 2014.
3. Loenneke, J.P., Young, K.C., Fahs, C. a., Rossow, L.M., Bemben, D. a., and Bemben, M.G. Blood flow restriction: Rationale for improving bone. **Medical Hypotheses**. 78: 523–527, 2012.
4. Nakajima, T., Kurano, M., Iida, H., Takano, H., Oonuma, H., Morita, T., et al. Use and safety of KAATSU training: Results of a national survey. **International Journal Of KAATSU Training Research**. 2: 5–13, 2006.
5. Scott, B.R., Loenneke, J.P., Slattery, K.M., and Dascombe, B.J. Exercise with Blood Flow Restriction: An Updated Evidence-Based Approach for Enhanced Muscular Development. **Sports Medicine**. 313–325, 2014.