

BLOOD FLOW RESTRICTION TRAINING GUIDELINES

These guidelines are intended to inform the safe application of Blood Flow Restriction (BFR) training. They may also be used as a reference for the development of minimum standards by National Sporting Organisations. It is recommended that NSOs, NIN partners and individual practitioners consider adopting these guidelines.

Overview

BFR is a training method that is increasingly being utilised within both strength and conditioning and rehabilitation settings throughout the Australian sporting system. BFR has been used in conjunction with resistance training, aerobic training, sport-specific training, during periods of rest, and following injury or surgery. There are potential safety issues associated with the method, and recent evidence suggests that practitioners lack clarity on how to apply BFR in the most safe and effective way.

Specific recommendations about dosage and prescription, and use of blood flow restriction for ischaemic preconditioning, are outside the scope of these guidelines.

As the body of evidence relating to BFR training continues to grow, the intention is to monitor research and clinical practice over time, and update these guidelines accordingly.

Pre-application of BFR

Indications for BFR

Low-load resistance training combined with BFR may be considered for use in both healthy and load-compromised populations for the purpose of increasing muscle strength and hypertrophy. However, current research suggests that it is unlikely to be any more effective than high-load resistance training at achieving these outcomes.

Aerobic exercise combined with BFR may also be considered to improve cardiorespiratory endurance as well as muscle strength and hypertrophy.

In trained athletes it has been suggested that optimal muscular adaptation may result from a combination of traditional resistance training and BFR methods. Preliminary evidence exists that using BFR in conjunction with sport-specific movement in trained athletes may also have a beneficial effect on physical qualities.

BFR may also be considered as a modality to control pain during exercise, improve bone health and reduce disuse muscular atrophy and strength loss. In addition to local effects of training, in some cases BFR training may also be used to target systemic, contralateral, proximal and distal training effects.

These are all areas of research growth that will continue to be monitored and updated within the guidelines as appropriate.

Athlete screening

It is recommended that practitioners require the completion of the BFR screening questionnaire by an athlete before the commencement of a BFR training program when:

- The athlete is using BFR for the first time; or
- The athlete has had a break from BFR training of >6 months; or
- The athlete has had surgery or significant injury/illness within the last 3 months.

This pre-screening form is accessible to strength and conditioning coaches (or equivalent), physiotherapists, doctors, and approved medical coordinators engaged through National Sporting Organisations (NSO) or the National Institute Network (NIN) via the Athlete Management System (AMS). To access the AMS form, contact the AMS team at ams@ausport.gov.au. For those outside the Australian NSO and NIN system a link to a PDF version of the pre-screening document can be [found here](#).

February 2021

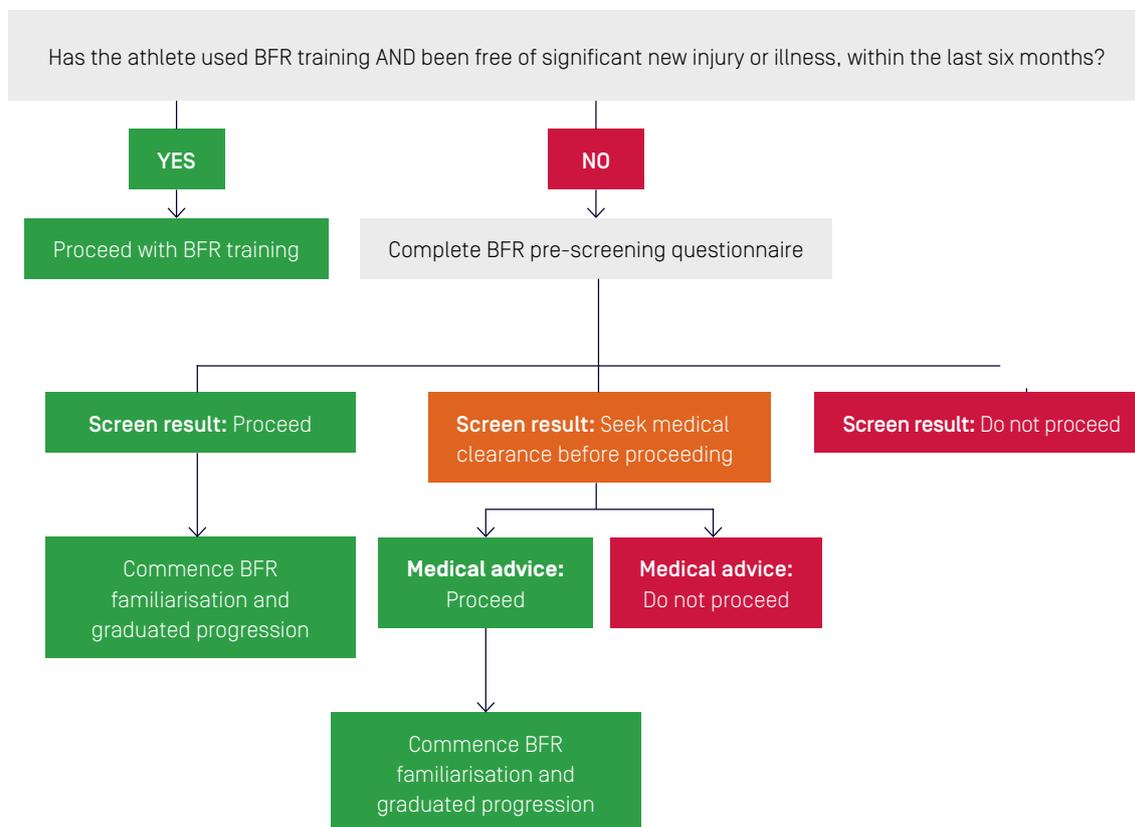
Athlete education and informed consent

Any athlete about to commence a course of BFR training should be educated about the potential risks, benefits and safe application of the technique.

The athlete should acknowledge this level of understanding and provide informed consent in their BFR pre-screening questionnaire.

The decision-making process recommended for assessing whether to proceed with BFR training is outlined in Figure 1.

Figure 1. Decision-tree on whether to proceed with BFR training



Para-athletes

Clinical reports exist relating to the safe use of BFR training by Para-athletes with a variety of impairments. The use of BFR training for para-athletes should be considered on an individual and case-by-case basis. Prescription and exercise selection may also need to be modified accordingly.

Due to potential complications relating to various impairments it is recommended that all para-athletes should have a medical review prior to commencing BFR training.

Safe application

General principles

When BFR training is new to an athlete, such training should commence with a familiarisation session and graded progression.

Athletes should avoid training to exhaustion when using BFR.

Exercise and BFR should stop immediately if the athlete is feeling unwell.

Training environment

Practitioners should exercise a higher degree of caution in hot and humid environments, including reminding athletes to maintain appropriate hydration levels. Dehydration may increase the risk of venous thromboembolism (blood clots), so BFR training should not be conducted when dehydrated.

Individualised Arterial Occlusion Pressures

Arterial Occlusion Pressure (AOP) is the pressure required to cease blood flow to a limb and is a reference point that can be used for the prescription of BFR training. There are a number of factors that can influence the pressure required to reach 100% AOP in an individual. These factors include individual blood pressure, limb characteristics, and the shape, width and length of the pressure cuff.

Accuracy of prescription is important to ensure both safety and training efficacy. It is recommended that practitioners measure and/or calculate individualised AOPs when prescribing and implementing BFR training. Doppler ultrasound techniques are considered the gold standard for measuring AOP in a limb. However, if not accessible to practitioners, the use of a sphygmomanometer or alternative automated blood pressure measurement device is recommended for this purpose.

It is recommended that an individual athlete's AOP should be recalculated at the start of any new block of BFR training.

During exercise, practitioners should be aware that factors such as variations in limb position, movement of a pressure cuff, and physiological changes within the athlete may influence the restriction of blood flow. Consequently, the use of automated BFR cuffs that have the ability to hold a desired pressure are recommended for use when they are accessible to an athlete.

Supervision

It is recommended that practitioners provide supervision of an athlete undertaking BFR training. In cases where an athlete is inexperienced in the use of BFR, practitioners must provide supervision of BFR training to ensure correct application and safety.

Where an athlete is competent in the application of BFR, and is in possession of the required equipment, then they may be able to use BFR training in unsupervised settings. These may include the use of BFR as a part of a home-based exercise program or during travel.

Where an athlete who is completing unsupervised BFR experiences a significant change to their medical health or physical condition, such as following injury or surgery, they should make contact with the practitioner who has prescribed their BFR exercise and undergo a reassessment, including the completion of the BFR screening questionnaire (Appendix 1), before recommencing BFR training.

General prescription guidelines

The application of BFR should be limited to less than 20 minutes for lower limb, and 15 minutes for upper limb, before allowing adequate time for reperfusion of tissues (3 min).

The width of the cuff used to apply pressure to a limb is a major determinant of the % AOP achieved at any given pressure. A wide variety of cuff widths have been studied and it is important to know that setting two cuffs with different widths to the same pressure will result in different amounts of blood-flow restriction. Cuff widths typically range from small (5cm) to medium (10-12cm) to large (17-18cm).

Although a wider cuff will generally require less pressure to achieve a desired % AOP, this does not necessarily equate to a safer stimulus. Ideally individualised AOP is calculated and the athlete should use the same cuff in training as was used during assessment."

In addition to normal exercise guidelines and precautions, in the case of para-athletes, consideration should be given to the effect of BFR in relation to an athlete's individual impairment.

As the body of evidence relating to BFR training continues to grow, the intention is to monitor research and clinical practice over time, and update these guidelines accordingly.

Based on current evidence, the following parameters represent safe and effective ranges of BFR prescription that may be prescribed during common modes of BFR training:

Context	Limb occlusion pressure
BFR with resistance training	<ul style="list-style-type: none">40-80% limb occlusion pressure and 20-40% 1RMExhale during exertion
BFR with aerobic training	<ul style="list-style-type: none">40-80% limb occlusion pressure.Exercise at <50% V_{O2}max or 50% HRR (heart rate reserve).
BFR during bed rest for prevention of muscle atrophy	<ul style="list-style-type: none">Limit BFR to 5 minute intervals with 3-5 min between sets.Up to 70-100% limb occlusion pressure is reported in the literature, however the research on this type of training is still developing, and it is recommended that practitioners use a conservative approach and avoid full arterial occlusion.

Medical Risk

Risks of BFR training

BFR training appears to be relatively safe with no definite evidence existing to confirm greater risk compared to other exercise modalities for the majority of athletes. However, high-quality research on the safety of BFR training is limited. Most studies on BFR training do not report on adverse events at all. Certain populations may be at increased risk of complications, and practitioners should have a low threshold for referring participants for a review to a medical doctor prior to commencing BFR training.

In order to obtain informed consent from participants, practitioners must explain what is currently known about risks and complications of BFR training, including limitations in the current knowledge base. Importantly, clinical practice and these AIS Best Practice Guidelines will need to be updated as further research on the safety of BFR training becomes available.

Most complications in BFR training that have been reported are through case reports, and there is an absence of high-quality research on rates of complications. The widest studies on complications have been surveys completed at KAATSU training centres, but the methodological limitations of these studies severely limit conclusions that can be drawn about complication rates. It should also be noted that only limited research on risk has been completed to date in athletic populations. Further evidence and guidelines can be extrapolated from surgical tourniquet use where there has been much more extensive safety research, although it should be acknowledged that there are key differences preventing a direct correlation.

Athletes with a history, or any suspicion of the following conditions should not undertake BFR training. If unsure, refer for review with a medical doctor to further assess. These absolute contraindications are:

- Peripheral vascular disease
- Previous vascular surgery to the effected limb
- An arteriovenous fistula to the effected limb.

The following are either relative contraindications, or medical conditions that may require individual consideration prior to commencing BFR training. Anyone with a history, or any suspicion of the following conditions must have a review with a medical doctor prior to commencing BFR training to assess whether it is safe for that individual:

- Hypertension
- Venous thromboembolism (including deep vein thrombosis or pulmonary embolus)
- Sickle cell disease
- Haemophilia or other bleeding/clotting disorder
- Cerebral infarction / stroke
- Peripheral neuropathy

Some para athletes may have altered sensation, altered autonomic response including autonomic dysreflexia, be at increased risk of VTE, and be more prone to other side effects such as pressure sores. Therefore, all para athletes should also be medically reviewed prior to commencing BFR training.

More detail about these and other potential complications are explained below. This is not an exhaustive list, so any athlete or practitioners with concerns about any other medical conditions should review or discuss these with a medical doctor prior to commencing BFR training.

Venous thromboembolism

Vascular occlusion could theoretically lead to thrombus formation, and case reports of venous thromboembolism (VTE) in the form of deep vein thrombosis (DVT) and pulmonary embolus (PE) following BFR training have been recorded. In a surgical tourniquet setting, VTE is usually listed as a potential complication but a direct correlation remains unclear. Increased fibrinolytic activity following tourniquet use may contribute to this finding. Those with a history of VTE or risk factors for VTE should be assessed further by a medical doctor prior to commencing BFR training, and it is likely that BFR training will not be appropriate for these athletes.

The oral contraceptive pill (OCP) may increase the risk of VTE in certain individuals. While the risk is small, and OCP usage is not listed as a contraindication to surgical tourniquet use, certain athletes may wish to discuss their own individual risk profile with their doctor before beginning BFR training.

Other cardiovascular considerations

Those with peripheral vascular disease have decreased vessel wall compliance making tourniquet use less effective, and potentially dangerous ischaemic damage could result. A history of hypertension or increased blood pressure (systolic blood pressure >140) on pre-screening should prompt review with a medical doctor prior to commencing BFR training.

One case of cerebral infarction with BFR training has been reported, however no further details are available, and this is not routinely listed as potential complication from surgical tourniquet use. Therefore, the relevance of this case is currently unknown.

Sickle cell disease may be a contraindication to BFR training as localised haemostasis, acidity and hypoxia caused by tourniquet use may provoke sickling of red blood cells. Sickle cell disease is also a risk factor for rhabdomyolysis which can occur with BFR training. Those with a history of sickle cell disease should be medically reviewed before considering BFR training, and it is likely that the risks will outweigh the benefits and preclude BFR training for these individuals.

Rhabdomyolysis

Case reports of rhabdomyolysis after BFR training have been documented. It is proposed that rhabdomyolysis may be more common with BFR training due to the magnified metabolic stress involved, however with the limited data available there is no clear evidence that the incidence is greater than with other risk of training. Anyone with a history of rhabdomyolysis should be reviewed by a medical doctor before commencing BFR training.

Nerve injury

Transient numbness and neuropathy have been reported following BFR training, but with no clear evidence of any long-term damage. Nerve palsies have been reported with surgical tourniquet, but the majority of cases are transient, and severity appears to relate to longer tourniquet times (mainly over 3 hours) which should not be applicable to BFR training. Both direct nerve compression and microvascular ischaemia have been implicated as potential mechanism of action. Symptoms or signs to suggest nerve involvement should be monitored for, with medical review if they persist.

Other considerations

Subcutaneous haemorrhage is not uncommon with BFR training but is self-limiting. However, those with a bleeding disorder such as haemophilia should have a medical review before commencing BFR training, as this group may also be at risk of other bleeding complications.

Pre-syncopal and syncopal episode are also reported and could result in a secondary traumatic injury in the training environment. This risk can usually be managed, but participants should be informed of these potential complications even if more minor.

Major BFR complications

Complication	Likelihood	Risk to health	Screening considerations
VTE (including DVT, PE)	Very Low	Catastrophic	Medical review for those at increased risk of thromboembolism (i.e. past history of thromboembolism, increased age, pregnancy, recent surgery).
Cerebral infarction	Association unclear	Catastrophic	Medical review for those with a past history of stroke.
Rhabdomyolysis	Low	High	Medical review for those with a history of rhabdomyolysis, and those with Sickle Cell disease. Assess training history and manage unaccustomed loads.
Hypertensive episode	Low	Moderate	Medical review for those with a history of hypertension or recorded hypertension on screening.
Subcutaneous haemorrhage	Moderate	Low	Educate that this can occur. Medical review for those with a bleeding disorder.
Nerve injury	Low	Low	Medical review if any persisting numbness.
Pre-syncopal / syncopal episodes	Very low	Low	Educate that this can occur and to notify the practitioner if dizzy. Setup and supervise a safe training environment.

Acknowledgements

These guidelines are an initiative of the Australian High Performance Sport System. The Australian Institute of Sport acknowledges the support of contributors and their organisations:

- Justin Crow, Paralympics Australia
- Brendan Scott, Murdoch University
- Harry Brennan, Victoria Institute of Sport
- Martyn Binnie, Western Australian Institute of Sport
- Alek Saunders, Paralympics Australia/South Australian Sports Institute
- Chris Gaviglio, Queensland Academy of Sport
- Peter Culhane, Australian Institute of Sport/Tasmanian Institute of Sport

February 2021

APPENDIX 1: BLOOD FLOW RESTRICTION PRE-SCREENING QUESTIONNAIRE

Athlete Name:

Date:

I have been informed about the potential risks and benefits associated with the use of BFR: Yes No

Please request this education before progressing any further with the questionnaire or BFR training.

BFR contradictions

Do you have peripheral vascular disease (circulatory problem involving the arteries to your arms or legs)? Yes No

Have you had vascular (artery or vein) surgery to your arms or legs before? Yes No

Have you had a skin graft to your arms or legs? Yes No

Do you have an arteriovenous fistula in your arms or legs? Yes No

BFR training is contraindicated in the case of answering yes to any of the questions above. Do not proceed with BFR training. Discuss with your doctor if clarification about your condition or history is required.

BFR precautions

Do you have a cognitive impairment or physical impairment? Yes No

Have you ever been diagnosed with hypertension / high blood pressure? Yes No

Do you have a bleeding disorder (e.g. haemophilia)? Yes No

Do you have a blood clotting disorder (e.g. SLE (lupus), factor-V Leiden thrombophilia)? Yes No

Do you have a past history of deep vein thrombosis (DVT) or pulmonary embolism (PE)? Yes No

Have you had surgery in the last 12 weeks? Yes No

Have you had one or both legs, or arms, immobilised for some reason in the last 4 weeks (e.g. prolonged bed rest, or having your leg or arm in plaster or a 'moon boot')? Yes No

APPENDIX 1: BLOOD FLOW RESTRICTION PRE-SCREENING QUESTIONNAIRE

Have you ever had a stroke (haemorrhagic or thrombotic) or a transient ischaemic attack (TIA)?	Yes	No
Have you ever been diagnosed with cancer?	Yes	No
Have you been diagnosed with heart disease?	Yes	No
Have you ever had rhabdomyolysis?	Yes	No
Have you been diagnosed with diabetes?	Yes	No
Do you have sickle cell disease?	Yes	No
Have you ever had compartment syndrome?	Yes	No
Do you have a history of nerve damage or injury?	Yes	No
Have you had a previous complication or adverse event following BFR training?	Yes	No
Do you have any other medical conditions not covered above, that you think should be discussed with a doctor prior to commencing BFR training?	Yes	No
Are you pregnant?	Yes	No

If you answer yes to any of the questions above, do not proceed. Please arrange a consult with a doctor before commencing BFR training, to assess whether it is safe for you

Are you taking the oral contraceptive pill?	Yes	No
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The oral contraceptive pill may slightly increase the risk of blood clots. You may wish to discuss your individual risk further with your doctor before commencing BFR training.

Do you have any other medical conditions not covered above, that you think should be discussed with a doctor prior to commencing BFR training?	Yes	No
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Please arrange a consult with a doctor before commencing BFR training, to assess whether it is safe for you.

It is important to acknowledge that this is not an exhaustive list of medical conditions that should prompt medical review. Any participant with medical concerns should be encouraged to err on the side of caution and seek medical review prior to commencing BFR training.