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Review

Exercise & Sports Science Australia (ESSA) position statement on exercise prescription for patients with peripheral arterial disease and intermittent claudication

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ABSTRACT

Objectives: Peripheral arterial disease (PAD) is characterised by atherosclerotic stenosis or occlusion of the arteries of the lower limbs, resulting in an impairment of blood flow to the legs. Patients with PAD have a significant reduction in their physical capacity and are limited during activities such as walking by intermittent claudication.
Design: Position stand.
Methods: Synthesis of published work within the field of exercise training and peripheral arterial disease.
Results: Supervised exercise training is considered the most effective treatment for increasing exercise tolerance in patients with PAD, and is also associated with improvements in daily physical activity and quality of life, and a reduction is cardiovascular disease risk. Exercise should be prescribed and progressed for patients individually, taking into consideration their disease severity, exercise tolerance and relevant comorbidities.
Conclusions: While walking programs are beneficial and frequently prescribed, other forms of aerobic exercise such as cycling or arm-cranking may also be incorporated as tolerated by patients. Forty minutes of accumulated aerobic activity, three times per week, is recommended for most patients. Patients should be encouraged to commence exercise at a moderate intensity, and should stop and rest if claudication pain becomes severe. Resistance training should also be included on at least two days per week with the goal of improving muscular strength and endurance. Comorbidities such as musculoskeletal complaints, hypertension, diabetes and peripheral neuropathy are common in patients with PAD and may exacerbate their functional limitations. Given the high cardiovascular risk associated with PAD, it is important that patients are appropriately monitored during exercise.

1. Background

Peripheral arterial disease is an atherosclerotic disease characterised by occlusion (blockage) or stenosis (narrowing) of the lumen of peripheral arteries, which leads to a reduction in blood flow to the limbs. While the disease may affect the arteries of the upper limbs, most commonly PAD affects the arterial supply of the lower limbs. The prevalence of PAD is estimated to be 3–10% of the general population, increasing to 15–24% in people aged 70 years or older.[1] Being an atherosclerotic disease, PAD shares similar risk factors as cerebrovascular disease (CVD) and coronary heart disease (CHD). Risk factors include advancing age, cigarette smoking, hypertension, dyslipidaemia and diabetes.[1] Patients with PAD are at increased risk of cardiovascular events, and the rate of myocardial infarction, stroke and vascular-related death was reported to be 14.8% over a three-year period in a large international cohort of patients.[2] Despite the poor prognosis of patients with PAD the management of cardiovascular risk in these patients has been shown to be suboptimal in many cases.[3]

Intermittent claudication is the most commonly reported symptom of PAD, although there is a wide range of atypical leg symptoms also reported.[4] In most cases these leg symptoms are the first sign of the disease. Intermittent claudication is typically described as a cramp-like pain, ache or tiredness affecting the muscles of the calf,

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and sometimes the thigh and buttock, during walking and other forms of physical activity. It usually worsens with increased exertion and is only relieved by rest. More severe presenting symptoms of PAD include rest pain, non-healing skin ulcers, and gangrene (tissue necrosis) and are collectively referred to as critical limb ischaemia.

Diagnosis of PAD requires a thorough medical history, physical examination including pulse palpation, haemodynamic assessment and vascular imaging investigations. Specifically developed claudication questionnaires such as the Edinburgh questionnaire may also be used to aid diagnosis.[5] The ankle-to-brachial index (ABI) is a commonly used clinical measurement for the screening, diagnosis and haemodynamic monitoring of PAD. Systolic pressures are measured using a Doppler ultrasound probe and the ABI of each leg is calculated by dividing the higher of the dorsalis pedis or anterior tibial artery pressure by the higher of the left or right brachial artery pressure.[6] Under resting conditions in the supine position, an ABI <0.9 is indicative of PAD. Some individuals, such as those with diabetes or renal failure, have an ABI of greater than 1.4 because of incompressible tibial arteries, and in these instances the toe-brachial index, pulse volume recordings or Doppler waveforms may be useful to confirm the presence of PAD.[1,6] Typically, an ABI of less than 0.4 indicates more severe disease and is commonly found in patients who have rest pain and/or tissue necrosis. Treadmill walking tests may also be used to help confirm the presence of PAD and intermittent claudication, with a fall in ABI of 15% immediately after exercise being indicative of PAD.[1] Walking tests also provide the opportunity to quantify the patient's exercise tolerance through the measurement of pain-free and maximal walking distances and are a useful tool for measuring the effect of an exercise intervention. Constant load treadmill protocols where the patient is required to walk as far as possible at a set speed (e.g. 3.2 km/h) and grade (e.g. 10%) are most commonly used in the clinical setting and enable the response to an absolute workload to be established and then reassessed after intervention. Alternatively, incremental protocols with progressive increases in walking speed or gradient allow for the measurement of cardiorespiratory fitness, and exercise tolerance may be more reliably assessed with these protocols.[7] Such progressive load protocols also allow for the physiological and symptomatic responses at various submaximal loads to be monitored. Where treadmill assessments are not available, the six-min walk test is an effective alternative objective assessment and is currently recommended for older adults and those who may have difficulty undergoing treadmill testing.[8] Furthermore, six-min walk distance has been shown to correlate strongly with physical activity levels in patients with PAD, and may therefore better reflect walking capacity in day-to-day life.[9] As patients with PAD are often hypertensive and have an exaggerated pressor response to dynamic exercise,[10] it is recommended that blood pressure is monitored during exercise testing so as to establish a safe intensity of exercise for therapy.

Patients with PAD have poor muscular strength and endurance[11] and reduced cardiorespiratory fitness ($\dot{V}O_2$ peak).[12] Maximal walking capacity of patients with PAD is less than 50% of that observed in age-matched control subjects and the functional limitations associated with PAD are similar to that seen in severe heart failure. Such physical constraints have a significant negative impact on the patient's quality of life and are associated with heightened levels of depression.[13,14] Moreover, patients with PAD avoid physical activity because of the pain associated with activity and their poor exercise tolerance,[15] and this physical inactivity is associated with elevated mortality, independent of disease severity and age.[16] Thus, the management of PAD should focus on reducing cardiovascular risk and improving exercise tolerance.[1,8]

Cardiovascular disease risk reduction in PAD includes a broad range of strategies including blood lipid management (including statins), control of hypertension, control of diabetes, smoking cessation, weight reduction, and antiplatelet and antithrombotic therapy.[1,8] Medical management of patients with intermittent claudication may also include the prescription of vasoactive drugs, including the phosphodiesterase inhibitors Cilostazol or Pentoxifylline. These agents have been shown to improve walking capacity, although their effect on cardiovascular risk is not well established.[17] Ramipril, an angiotensin converting enzyme inhibitor that is commonly prescribed as an antihypertensive agent, has also recently been shown to increase walking capacity in a randomised controlled trial.[18] Lower limb revascularisation, which may include surgical bypass operations or endovascular angioplasty procedures, provides a means of improving leg blood supply and is commonly undertaken for patients with limiting PAD. The primary goal of revascularisation is limb salvage with elimination or reduction of symptoms. In some centres, revascularisation is reserved for patients with more severe symptomology including critical limb ischaemia. Revascularisation procedures may also be indicated for patients with claudication that is vocational or lifestyle limiting, particularly patients who are non-responsive to exercise training or pharmacotherapy.[1,8]

Systematic reviews of clinical trial data suggest that one of the most effective treatments for improving exercise capacity and functional ability in patients with PAD is supervised exercise therapy.[19–22] Exercise therapy is currently recommended as part of the initial treatment for all patients with intermittent claudication due to PAD.[1,8,23] This position statement outlines the benefits of supervised exercise therapy and the current exercise prescription guidelines recommended for practitioners working with patients diagnosed with PAD.

2. Benefits of exercise training for PAD

The positive effects of regular exercise for patients with PAD were first described by Erb in 1898.[24] Almost a century later, a meta-analysis of 21 studies reported that exercise training, usually incorporating supervised treadmill walking, improves the pain-free walking distance of PAD patients by 179%, and their maximum walking distance by 122%.[20] More recently, a meta-analysis of randomised controlled trials demonstrated that exercise training programmes of 3–12 months duration improve maximal treadmill walking time by an average of approximately five minutes (range: 4.5 to 5.7 min), corresponding to a relative improvement of 50–200%.[21] Changes in walking capacity are often, but not always,[25] accompanied by changes in the strength and endurance of the plantar flexion muscle group,[26] which is the site of symptoms for most patients and is often considered to be the limiting muscle group for patients during walking and other activities.[27] Indeed, plantar flexion training has been shown to be an effective mode of exercise for improving walking capacity in patients with PAD.[28] Patients who have undergone exercise therapy also frequently report improvements in their self-reported functional capacity, and there is also improvement in their quality of life scores.[29] Free-living daily physical activity, measured using self-report methods and accelerometers, has also been shown to increase in some studies with training,[30] but not in others,[29] hence warranting further study. The direct effect of exercise training on cardiovascular risk factors has been seldom investigated, although exercise therapy has been shown to improve total cholesterol, low-density-lipoprotein cholesterol, and systolic blood pressure in a small group of patients with PAD.[31] Preliminary data also demonstrate that event-free survival over a five-year period is higher in PAD patients who participated in a 12-week supervised exercise programme compared with those who did not.[32]

Table 1
Exercise prescription recommendations for patients with peripheral arterial disease.

Type of exercise	Intensity	Session duration	Frequency
Aerobic training			
Interval walking	To the point of moderate claudication pain (e.g. 4 out of 5)	Progress as tolerated to 40 min, excluding rest periods	3 supervised sessions per week
Other aerobic exercise (involving large muscle groups, including upper body)	Moderate intensity (RPE 3–4/10); progress to vigorous as tolerated (RPE 5–6/10)		
Resistance training			
Whole body (large muscle groups with emphasis on lower limbs if time is restricted)	Progressively overload 60–80% 1 RM	6–8 exercises 2–3 sets 8–12 repetitions	2 sessions per week on non-consecutive days

Exercise should be prescribed and overloaded to meet the individual needs of patients. For patients who are severely limited there will be a need to commence exercise at lower intensities and shorter durations than those recommended. RPE, rate of perceived exertion; RM, repetition maximum.

There is a positive relationship between the improvement in walking capacity and the improvement in $\dot{V}O_{2peak}$ with supervised exercise training,[30] suggesting that the benefits of exercise training arise from an enhanced delivery of oxygen to the working muscle and/or an improvement in the ability of the working muscles to utilise oxygen. While there is some evidence that the improvement in exercise capacity is associated with improved limb blood flow,[30] most investigations have failed to find any such haemodynamic effect with training.[21,33] In a comparison of lower limb percutaneous transluminal angioplasty and exercise training, it was demonstrated that angioplasty lead to a significant improvement in ABI and only a modest gain in walking capacity, whereas exercise training lead to large increases in walking capacity with no change in ABI.[34] This apparent dissociation between limb haemodynamics and exercise capacity in PAD patients has led to some debate about the underlying causes of exercise intolerance in PAD patients,[35] and has prompted the investigation of various other mechanisms that might underpin the benefit of exercise training in this population. Generally, improvements in $\dot{V}O_{2peak}$ with exercise training in PAD are specific to the mode of exercise used[36]; however, studies demonstrating that arm-cranking exercise leads to improvements in walking capacity suggest that there may be central physiological adaptations contributing to the benefit of exercise training.[37] While cardiac output does not change significantly with lower-limb training in PAD,[28] improvements in the rheological properties of the blood and a reduction in blood viscosity may explain this cross-training effect.[38] Additionally, an improvement in blood flow distribution and oxygen extraction during exercise might be facilitated through an improvement in endothelial function and the ability of vessels to vasodilate,[29] or through an increased muscle capillary network.[39] Patients with PAD have an altered gastrocnemius muscle phenotype,[40] and training induced changes in muscle morphology or metabolism may also contribute to the improved exercise tolerance.[12,41] Patients with PAD have an impaired gait and walking programmes have been shown to improve walking economy at submaximal workloads.[42] Patients may improve their tolerance for pain with training, thereby improving their exercise capacity.[43]

3. Exercise as part of the clinical management of PAD

There are currently a wide range of clinical guidelines available for the management of patients with PAD.[1,8,23] These existing guidelines are broad evidence-based recommendations that cover all aspects of patient management including screening and diagnosis, medical management and surgical intervention for the full spectrum of vascular diseases. While these clinical guidelines provide a recommendation about the use of exercise training for PAD, they are aimed at primary- and specialist-health care providers (e.g. vascular surgeons) and lack sufficient detail to guide individualised exercise prescription. Therefore, this position statement provides an extension of the available clinical guidelines, and is aimed at exercise physiologists and other allied health professionals who are responsible for the development and delivery of exercise programmes specifically for patients with PAD and intermittent claudication.

The exercise recommendations presented within this position statement draw on current clinical guidelines[1,8,23,44] and recent systematic reviews and meta-analyses of the literature,[20–22,45] as well as the authors' combined experience of prescribing exercise to this cohort. Where possible, specific studies that have been cited within the recommendations below have been drawn from a recent systematic review of 44 studies[22] that were assessed for quality using the Physiotherapy Evidence Database scale (PEDro).[46] Quality criteria included, but were not limited to, randomisation, concealed treatment allocation, baseline homogeneity, and the use of 'intention to treat analysis'. Overall quality of the included trials was moderate, with an average 5 of the 10 quality criteria being present. Studies were not prioritised according their quality score, however all studies met the minimum criterion of being a randomised controlled trial.[22]

4. Exercise prescription recommendations

An overview of the exercise prescription recommendations for patients with PAD and claudication are presented in Table 1. The authors recommend that individualised exercise prescription for a person with PAD should aim to improve not only walking ability, but also risk factors for disease progression. As per ESSA and ACSM guidelines,[47,48] cardiovascular and medical/injury risk status should be assessed by the exercise physiologist or health professional prescribing the exercise, and further relevant information (e.g. ECG, cardiac imaging and/or stress test findings), and clearance if appropriate, should be gained from the patient's general practitioner and/or medical specialist (i.e. cardiologist or vascular surgeon) prior to commencing an exercise programme. It is recommended in the AHA clinical practice guidelines that baseline exercise tests (treadmill) should be performed in PAD patients prior to undergoing exercise training so as to determine functional capacity, assess nonvascular limitations, and demonstrate the safety of exercise.[8]

4.1. Exercise programme duration

Patients should aim to complete at least 6 months of exercise training,[20,21] although with effective exercise prescription some improvement in walking ability should be noticed within the first 2 months after commencement of exercise training. The only randomised controlled trial to assess the influence of programme duration showed significant gains in walking distance in the first

2 months of a 6 month exercise training programme, when compared to months 2–4 and 4–6,[49] which is consistent with the notion that supervised training beyond 2–3 months results in a reduction in continued gains in exercise tolerance.[45] Given the poor habitual activity levels and high cardiovascular risk associated with PAD, patients should be supported to include physical activity as a regular part of their lifestyle on an ongoing basis.

4.2. *Exercise session frequency and duration*

To our knowledge there have been no randomised controlled trials to determine the effect of exercise session frequency or duration on walking ability in PAD. A recent review reported that supervised exercise programmes incorporating 2–3 sessions per week for 40 min per session, regardless of intensity, leads to significant improvements in pain-free and maximum walking distances.[22] Participation in more than three supervised sessions per week is not likely to result in any further significant gains for the patient over the course of the program,[45] and patient motivation and adherence should be considered when determining the frequency of supervised sessions. In some cases it may be appropriate to supplement supervised sessions with home-based exercise sessions to increase total exercise volume or accommodate barriers that might be associated with attendance at a supervised programme (e.g. transport, work commitments). Given the intermittent and limiting nature of claudication it is usually difficult for patients to sustain continuous periods of exercise, particularly during the early stage of a programme. For this reason, the prescription and monitoring of exercise session duration should take into account the total session time, time spent exercising and time spent resting. In the initial stages of a programme 10–20 min of accumulated exercise might be feasible during a single session,[36] and it may take 6 months or longer to progress to 40 min of continuous exercise.[50] A long term goal for most patients should be to increase activity levels to meet the minimum 150 min of recommended aerobic activity each week for older adults, and this should be done progressively by manipulating the specific exercise prescription to suit the individual patient.[48]

4.3. *Aerobic exercise training*

For those patients amenable to walking, interval walking at maximum-tolerable walking speed is the most frequently recommended mode of exercise for this population. Three sessions per week where 40 min or more of walking is accumulated in each session consistently leads to improvements in walking capacity,[22] although there is a need for many patients to be gradually progressed to this volume of exercise. Few studies have systematically investigated the effects of exercise intensity in PAD, although it is generally accepted that when the total volume of exercise (i.e. work) is controlled, there is no difference in the improvements achieved with high and low intensity exercise.[51] Walking intensity is usually monitored using a claudication rating scale, e.g. where 0 = no pain and 5 = maximum pain, and exercise that induces claudication pain of moderate severity (e.g. 4 out of 5) is often prescribed. Walking at a lower intensity, with no pain or to the onset of mild claudication pain (e.g. 2–3 out of 5), may be just as effective.[22] The patient's individual heart rate and blood pressure response should be monitored routinely and should also be taken into account when determining the intensity of exercise. For those patients who find walking difficult to complete due to early-onset or intolerable claudication pain, or other co-morbidities, other forms of continuous lower limb aerobic exercise such as lower limb aerobic circuit training (generally involving the calf, quadriceps and hamstring muscle groups)[52] and pole-striding[53] (walking whilst using poles) have also been effective at improving walking ability. Upper body aerobic exercise is currently understudied, however, recent trials have demonstrated an improvement in walking ability with arm-cranking exercise[43] and this mode of exercise may be an effective adjunct to lower limb aerobic exercise training. Stationary cycling is a mode of exercise that is safe and widely available and may assist to improve cariorespiratory fitness in deconditioned patients, although the benefits of cycling do not transfer to walking in all patients.[36] Intensity targets for these alternate exercise modes should be commenced at a moderate intensity, commencing at a rating of perceived exertion (RPE) of 3–4 on a 10-point Borg scale, and progressed as tolerated towards an RPE of 5–6 (vigorous intensity), which is recommended for older adults in order to address cardiovascular risk and minimise the physiological effects of an otherwise sedentary lifestyle.[48]

4.4. *Resistance exercise training*

Only a small number of trials have systematically studied the effect of conventional resistance training on walking ability in PAD. Findings to date have been conflicting, with some studies showing no improvement in walking ability, and others reporting as much as a 63% improvement.[22] A randomised controlled trial comparing treadmill-walking exercise and resistance exercise found greater increases in 6-min walk distance in the treadmill exercise group, and greater improvements in leg-extension strength and power in the resistance exercise group.[29] In contrast, a recent trial demonstrated that high-intensity progressive resistance training led to significant gains (∼62 m) in 6-min walk distance.[54] While resistance training might only provide a small-to-modest improvement in walking ability in PAD compared with walking programmes, resistance training leads to other functional improvements and may also contribute to cardiovascular risk reduction in older patients.[55,56] The authors recommend a minimum of two, ideally three, sessions per week, performed on non-consecutive days. Resistance training is usually prescribed in addition to walking or other forms of aerobic exercise, although it should be noted that the effects of this combined approach have not been systematically examined in PAD. Where safe and appropriate, moderate to high intensity resistance exercise (60–80% 1 repetition maximum (1RM)) should be employed in accordance with general recommendations for healthy adults.[57] Training should be progressive with monthly reassessments, and the heart rate and blood pressure response to resistance training should be routinely monitored. Patients should undertake 3 sets of 8–12 repetitions with 1–2 min rest intervals of whole body progressive resistance training (PRT) incorporating 6–8 exercises including the primary muscle groups involved in walking (i.e. gastrocnemius, tibialis anterior, quadriceps, hamstrings and gluteals). If time is restricted, attention should be directed to strengthening the muscles of the lower limbs given that improvements in leg muscle function are sometimes accompanied by improvements in walking capacity in PAD.[28]

4.5. *Supervision of exercise programmes*

Direct comparisons between supervised and non-supervised programs,[19] and a review of outcomes from randomised controlled trials,[22] demonstrate that supervised programmes are generally more effective for this patient group than unsupervised programmes. Compared with the advice to "go home and walk", a randomised trial across 11 centres found that a supervised exercise programme was more effective for improving walking capacity and quality of life in patients with intermittent claudication.[58] A more recent randomised controlled trial demonstrated that a home-based walking programme, which incorporated a group-mediated cognitive behavioural intervention, achieved significant improvements in six-min walking distance, maximal treadmill walking

time and daily physical activity compared with a health education control intervention.[59] On the basis of this evidence, supervised exercise therapy for PAD and intermittent claudication is recommended whenever possible, and home-based programmes may be a feasible and effective alternative for patients who are unable or unwilling to participate in supervised exercise programmes. While adherence to supervised and unsupervised exercise programmes has been shown to be similar,[60] it has been suggested that patients may not fully comply with exercise instructions (e.g. intensity targets) during home based programs.[61] This highlights the importance of effective motivational and behaviour change strategies in supporting patients to comply with exercise goals and increase their levels of daily physical activity. A recent trial demonstrated that adding motivational interviewing techniques and behaviour change counselling strategies to unsupervised exercise significantly increased daily walking behaviour, measured as steps per day, at four months compared with unsupervised exercise advice alone.[62] While further research is needed to establish the most effective methods of maintaining the benefits of supervised exercise training and supporting patients in developing positive changes in physical activity behaviour, established methods such as motivational interviewing, behaviour change and cognitive behavioural therapy should also be considered when addressing the specific needs of individual patients.

4.6. Special considerations for patients with PAD and intermittent claudication

As patients with intermittent claudication are at high risk of other cardiovascular diseases, improvements in their walking ability may unmask signs and symptoms (e.g. angina, unusual shortness of breath, adverse blood pressure responses, ST-segment depression, other arrythmias) of cardiac ischaemia.[8] Care should be taken to establish and monitor closely those at risk of a cardiovascular event, and if signs and symptoms appear prompt re-evaluation from the patient's medical specialist should ensue. As previously mentioned, the pressor response to exercise may be exaggerated in PAD patients,[10] and heart rate and blood pressure should be monitored during all exercise testing and therapy sessions. Patients with PAD will be commonly prescribed medications (e.g. antihypertensive agents) that may affect their heart rate and blood pressure response to exercise.[1] Exercise physiologists and other health professionals should monitor changes in medications and any alterations in the patient's response to exercise.

Peripheral neuropathy affects some patients with PAD, particularly those with concomitant diabetes, and this may negatively affect their balance and increase the risk of lower limb wounds or lesions. Patients with PAD are prone to impaired healing of wounds to the lower limb, and some patients may be prescribed antiplatelet agents (e.g. aspirin) or antiocoagulants (e.g. Warfarin), which may further increase the risk of bleeding. Appropriate and proper fitting footwear should be worn by patients during exercise, and care should be taken with the use of exercise equipment and the transferring of resistance weights.[1]

Patients with PAD and systemic atherosclerosis have an elevated risk of Abdominal Aortic Aneurysm (AAA), which is characterised by dilatation of the aorta beyond its normal size. There is evidence that enhanced cardiorespiratory fitness improves surgical outcomes for patients who require AAA repair[63] and as such exercise and physical activity should not be avoided by these patients.[8] However, further research is needed to help identify safe and effective exercise prescription guidelines for this cohort. There are published reports of exercise related aneurysm rupture or complications following maximal exercise in two patients who had aneurysms greater than 6 cm in diameter,[64,65] and another patient with a history of coronary artery disease suffered a cardiac arrest during moderate intensity exercise training.[66] With these risks in mind, it has been suggested that patients with AAA should initially undertake exercise training in a centre where appropriately trained staff and resuscitation equipment are accessible. Patients with a AAA larger than 5 cm in diameter or a symptomatic AAA should not take part in an exercise programme.

Many patients with PAD will have an array of co-morbidities including musculo-skeletal conditions, diabetes, hypertension and obesity that may affect their exercise tolerance[67,68] and ability to complete an exercise programme. Some patients may also have contra-indications to exercise such as unstable CHD, neurological impairments or musculoskeletal limitations. These patients should be stabilised and, if warranted, evaluated by their general practitioner or medical specialist prior to commencing any form of exercise therapy.

There are currently no guidelines on the use of exercise therapy as an adjunct to surgical or endovascular revascularisation, although there is evidence that the addition of exercise training to reconstructive surgery or angioplasty is more effective at improving walking ability than surgery alone.[69] In such cases care should be taken to ensure that the patient has adequately recovered from revascularisation prior to the commencement of exercise. This is likely to require a period of up to six weeks, depending on the extent and site of surgical wounds, and should be determined in conjunction with the patient's general practitioner or vascular surgeon.

5. Summary

Peripheral arterial disease (PAD) is an atherosclerotic disease where blood flow to the lower limbs is impaired. Treatment for PAD aims to alleviate symptoms, improve functional capacity and reduce cardiovascular risk. Supervised exercise training is recommended as part of the initial treatment for all patients. Exercise training achieves improvements in exercise capacity without significant changes in maximal blood flow capacity to the limbs, and it is likely that increases in muscular strength and various physiological adaptations, including alterations in muscle morphology and metabolism, contribute to the benefits of exercise training in PAD. Exercise prescription for PAD is complicated by the high cardiovascular risk and the various comorbidities that are often associated with the disease, and for this reason individualised programmes should be prescribed and supervised by exercise physiologists and other appropriately trained health professionals.

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