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ARTIGO DE REVISÃO

Exercícios resistidos em idosos portadores de insuficiência arterial periférica

Resistance exercises in peripheral arterial diseased elders

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RESUMO

O envelhecimento da população mundial propiciou o incremento das doenças crônico degenerativas, colocando a comunidade científica diante de um grande desafio na busca e escolha dos melhores e mais econômicos tratamentos. A doença arterial periférica, que surge como complicação da aterosclerose, apresenta incidência que aumenta linearmente com o avançar da idade, somando-se, portanto, a diversas outras patologias que já acometem este grupo populacional. A documentação dos benefícios em custo e eficácia, da utilização de exercícios como indicação primária para o tratamento de pacientes idosos, tornou-se excelente alternativa para este grupo populacional, que já utiliza diversas medicações, devido a outras doenças crônicas.

Os benefícios dos exercícios resistidos foram ainda pouco explorados como forma isolada de tratamento da doença arterial periférica em idosos, mas já deixam indícios que esta forma de exercícios pode e deve ser utilizada para o tratamento da patologia referida, pois pode reverter ou retardar as concomitantes alterações degenerativas que acometem seus portadores, diminuindo de forma significativa as muitas limitações impostas pela doença em associação com o envelhecimento sedentário.

PALAVRAS-CHAVE

levantamento de peso, terapia por exercício, claudicação intermitente, arteriosclerose, saúde do idoso

ABSTRACT

The aging of the world population has provoked an increase of chronic degenerative diseases, facing the scientific community with the challenge to search and choose the best and most feasible treatments. Peripheral arterial disease, which appears as a complication of arteriosclerosis, shows increased and continuous incidence as age progresses, therefore adding to several other diseases that ensue this portion of the population. The conclusive evidence of efficiency and cost-benefits in the use of exercise as a primary indication for the treatment of aging patients has become an excellent alternative for this population group, which already uses various medications due to other chronic diseases. The benefits of resistance exercise still have not been fully explored as an isolated treatment for peripheral arterial disease in aged persons, however has already indicated that this form of exercising can and should be used for the treatment of the referred pathology, since it can reverts or delays the associated degenerative alterations which commits their carriers, diminishing significantly the many limitations imposed by the disease in association with sedentary aging

KEY-WORDS

weight lifting, exercise therapy, intermittent claudication, arterial occlusive diseases, geriatrics

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Introduction

The increasing rise of the world's elderly population, associated to the technological innovations of modern society and consequent sedentary lifestyle result in an ever-increasing number of elderly individuals with chronic diseases[1,2].

Among the countries with the largest elderly populations expected in 2025, Brazil occupies the sixth position. This future sixth position already takes into account the alarming current data on the mean number of diagnoses per patient of pathologies that impair functionality. Considering the elderly individuals who are either outpatients, in homecare or institutionalized patients, these numbers are 3.5, 4.8 and 6.2, respectively[1].

Atherosclerosis is one of the main pathologies in this age range. This disease has systemic manifestations, with a degenerative effect on medium and large-caliber arteries. Its manifestation can be acute or chronic, leading to ischemic distress of organs distal to the lesion, in cardiac, brain and peripheral sites[3].

The importance of this pathology can be traced as far as Hippocrates' time more than 20 centuries ago, being currently considered the disease with the highest morbimortality among the elderly[3].

When there is progression of atherosclerosis, with decreased arterial blood flow and consequent deficit in oxygen supply to the regions that are distal to the aortic bifurcation, the disease is called peripheral arterial disease (PAD)[4].

PAD is a pathology that requires thorough attention, as it is closely related and very often concomitant to cardiovascular and cerebrovascular diseases (systemic manifestations of atherosclerosis). This fact can generate an increased number of ischemic events and their consequences, such as loss of independence or even death[5].

Morbimortality rates and the presence of associated cardiovascular disease accompany the affected individuals, with an incidence of 18% in males and 14% in females[6]. Brazilian data show an incidence of 27% of associated cardiovascular disease (angina, acute myocardial infarction and stroke)[7].

The most frequent clinical manifestation (15-40%) is pain while walking that prevents its continuity and is relieved by resting only. The pain, which can also be referred to as fatigue, tingling or cramps, affects parts of the lower limbs depending on the blood flow obstruction site[8] (Chart 1).

Intermittent claudication is not necessarily observed in all those who present the pathology. However, among those who do present the symptom, the diagnosis is confirmed is most of the cases[5].

Chart 1
Subjective classification of pain in PAD during exercise[9].

Level 1	Defined discomfort or pain but at an initial or mild level (established, but bearable.)
Level 2	Moderate discomfort or pain, where the patients' attention can de deviated, such as by conversation, for instance.
Level 3	Intense pain, from which patients' attention cannot be deviated.
Level 4	Unbearable pain and discomfort.

It has been observed that the elderly exhibit a low incidence of claudication, with 6% of men older than 85 years and 2.5% of women older than 85 years presenting the symptoms of claudication. Such numbers are explained by the fact that the elderly either do not exercise enough (sedentary lifestyle) to present such symptoms[4] or die due to associated comorbidities[7]. Brazilian data are also discreet, with 2.5% of symptomatic elderly individuals (1.9% of men and 0.6% of women)[7].

PAD prevalence studies show a broad variation of data. Such variation is explained by the different characteristics of the studied population, where factors such as age, accepted normal values for the ankle-arm index (AAI – the ratio between the systolic arterial pressure of the posterior tibial artery and the brachial artery) and the presence of risk factors and/or associated comorbidities are the main contributors.

Prevalence increases with aging, with values equal to 13.4%, 14.5%, and 52%, for individuals older than 65, 70 and 85 years, respectively[4,5,10].

The values considered within the normal range for AAI varies among studies (0.80-0.95); however, most of them show a cutoff of 0.90, below which the diagnosis of PAD would be confirmed[4].

Risk factors and/or associated comorbidities are similar to those related to cardiovascular diseases. Individuals with PAD present a higher percentage of risk factors (systemic arterial hypertension, diabetes mellitus, dyslipidemia, obesity, smoking, increased inflammatory markers such as C-reactive protein and fibrinogen, decreased renal function and sedentary lifestyle). The individuals who present the aforementioned pathologies and/or risk factors have an increased risk of developing PAD[5,10].

No differences were observed regarding the incidence between sexes, when gender was considered a risk factor[5,10], although it has been suggested that men present a 2-5 fold higher incidence when compared to women[11]. On the other hand, ethnicity showed to be a risk factor, as Black individuals presented higher incidences of the disease when ethnicity was considered a risk factor[10].

The data reported in literature can be diverse and even more alarming, as less than half of the patients know about their condition and doctors underdiagnose 70% of the patients with the pathology[6].

The reduced blood flow and consequent decrease of oxygen supply in PAD generate a cycle of progressive impairment, which, through a chain of events, leads to: endothelial dysfunction, reperfusion ischemia, systemic inflammation and free radical release, atrophy and denervation of muscle fibers, muscle metabolism alterations, muscular strength and endurance reduction, walking capacity and quality of life impairment, deconditioning and sedentarism. As a consequence, these can lead to obesity, systemic arterial hypertension (SAH), dyslipidemias (DLP), diabetes mellitus (DM) and increased risk for thrombosis[8].

There are contradictory data on musculoskeletal and neural alterations in PAD due to the chronic ischemia, being either increased, decreased or showing no alteration in some studies[12-16].

Among the factors analyzed are: muscle mass amount, percentage distribution pattern of fiber types, capillarization, biochemical and nervous alterations.

A possible justification for such contradictory results might be the heterogeneity of the controlled variables of the studied population; additionally, age, time and severity of the disease, risk factors or associated morbidities, level of physical activity, level of flow obstruction, type of medications used and analysis methods can significantly contribute to this fact.

The most recommended treatments reported in recent literature reviews include the invasive ones, such as percutaneous transluminal angioplasty (PTA) and surgery (BYPASS) as well as the non-invasive ones such as pharmacotherapy (Cilostazol and Pentoxifilin) and exercises[8,17-20].

The exercise therapy must be indicated mainly due to its high efficacy (72.5% of the patients improve with this single intervention)[21], low risk (no reports of adverse effects)[20] and low cost (US$ 61 less per meter gained at treatment)[22].

Surgical interventions are indicated for cases of ischemia at rest and/or associated gangrene (Fontaine Functional Class III and IV) (Chart 2), or cases in that do not present improvement with the clinical treatment and present good patency rates (96%) in a subsequent year[21].

Chart 2
Fontaine Classification for PAD[23].

Stage	Symptoms
I	Asymptomatic
II	Intermittent claudication
IIa	Distance until start of pain > 200 metros
IIb	Distance until start of pain > 200 metros
III	Pain at rest
IV	Gangrene, tissue loss

Physical exercises showed to be the best therapy regarding mid-term and long-term cost-benefit, when independently compared to the other types of treatment (pharmacotherapy, BYPASS and PTA) and presenting additional benefits when associated to other types of treatment[22,24,25].

Several types of exercises have been performed by individuals with PAD (walking, arm and leg ergometry, climbing stairs and resistance exercises, among others), with walking presenting the most advantages[19].

This review was proposed due to the fact that most of the benefits for the patients' capacity of deambulation were obtained through walking exercises, with just a few references and much controversy regarding the results about the real benefits of resistance exercises.

Resistance exercises have been previously indicated[12,14-16,26-29] due to the fact that a significant improvement of the hemodynamic patterns were not observed with training, suggesting that the clinical improvement observed were due to muscular characteristics (increase of muscular oxidative metabolism and possible hypertrophy).

Some of the alterations in PAD such as loss of muscle mass (sarcopenia), alterations of the percentage distribution pattern of fiber types (with higher atrophy of type IIa fibers, mainly), alterations and decrease of nervous functions (decrease of the velocity of conduction and decrease of motor neurons) as well as the decrease in strength and endurance are similarly observed in elderly individuals without the pathology[30].

In this population, the resistance exercises act by delaying or reversing such degenerative processes caused by aging and sedentary lifestyle[31-38] (Chart 3).

Chart 3
Alterations caused by aging and strength training[39].

	Aging	Strength training
Muscular strength	Decreases	Increases
Muscular endurance	Decreases	Increases
Muscle mass	Decreases	Increases
Hypertrophy capacity	Decreases	Increases
Muscle metabolic capacity	Decreases	Increases
Metabolic rate of muscle at rest	Decreases	Increases
Body fat composition	Increases	Decreases
Bone mineral density	Decreases	Increases
Physical functions	Decrease	Increase

Chart 4
Effects of resistance exercises on several health variables[35].

Body composition	
Bone mineral density	↑↑
% fat	↓
Lean mass	↑↑
Strength	↑↑↑
Glucose metabolism	
Insulin response to glucose stimulation	↓↓
Levels of basal insulin	↓
Insulin sensitivity	↑↑
Serum lipid levels	
HDL	↑↔
LDL	↓↔
Cardiac frequency at rest	↔
Cardiac output, rest and maximum	↔
Arterial pressure at rest	
Systolic	↔
Diastolic	↓↔
Maximum oxygen consumption	↑↔
Time of endurance, maximum and submaximum	↑↑
Basal metabolism	↑↑

↑: values increase; ↓: values decrease; ↔: values remain the same. One arrow: slight change; two arrows: medium change; Three arrows: significant change.

The benefits attributed to this type of training range from changes in the muscular structural characteristics (hypertrophy of all types of fiber and increase in capillarization) to the positive influence on several secondary factors related to health (Chart 4).

The resistance exercises reach all components of physical fitness[40], with predominance of those considered the most important for accomplishing daily life activities: strength and flexibility[41,42].

Studies have shown that the elderly respond to strength training, regarding muscular characteristics, similarly to younger individuals[32,37].

Finally, resistance exercises can be performed safely and effectively (with a lower incidence of adverse effects when compared to continuous exercises), even by elderly individuals and those affected by miscellaneous pathologies[33,43-45].

Literature Review

A review was conducted based on the electronic data from BIREME, PUBMED and COCHRANE. Using terms related to resistance exercises (Resistance - training/exercise; Resistive – training/exercise; Strength – training/exercise) along with terms related to PAD (Peripheral – arterial disease/vascular disease/arterial occlusive disease/arterial insufficiency; Chronic – arterial insufficiency/occlusive arterial disease; Intermittent claudication; Claudication pain; Arterial occlusive disease; Vascular occlusive disease), the outcome was 180 different results.

The studies considered significant were obtained using the references found, as well as the references contained in those studies, especially through OVID.

Walking exercises in PAD

In some recent original studies[26,27,46-50], five reviews[8,9,18-20] and one meta-analysis[17], some characteristics that better constitute an exercise program were observed. Among them are:

- TYPE/MODALITY: walking.
- LOCAL/STRUCTURE: on a treadmill and under supervision.
- INTENSITY: “moderate” (enough for the symptoms of claudication to appear in 3-5 minutes, followed by rest until their cessation).
- SESSION LENGHT: 30-60 minutes (including 5 initial and final minutes, for warm-up and rest, respectively).
- FREQUENCY: at least twice a week[2-5].
- TOTAL VOLUME: no established definition; however, with a suggested volume of approximately 6 months.

The supervised groups presented the best results in programs of up to 6 months of duration, albeit with a higher operational cost. The non-supervised groups presented better adherence in programs with more than two years of duration[51] with advantages related to cost for the patients[48], despite the less effective results, but presenting a satisfactory degree of effectiveness when well supervised by the professional[19].

In a recent study, Gardner and cols[17] evaluated the intensity of walking related to the improvement of performance in a 6-month program, and observed a high similarity (109% *vs*. 109%, for the distance of start of pain when walking; and 61% *vs*. 63% for maximum distance of pain when walking, respectively) between the low intensity (40%) and high intensity (80%) groups.

Improvement in patterns of walking obtained during the first six months of an exercise program tend to reach a plateau[19,46,47] or exhibit a slight improvement after this period. Improvements can be already observed with programs with a 4-week duration[17].

The physiological, mechanical and metabolic mechanisms that can explain the reported symptom improvement presented by the affected individuals are[8,17,18,26,28,29,46,49,50,52]:

- Improvement in muscular metabolism and oxygen extraction;
- Improvement in endothelial function;
- Reduction of systemic inflammation;
- Increase and better distribution of collateral arterial blood flow;
- Improvement of the hemorheological patterns (less viscosity and higher blood filterability).
- Improvement in gait biomechanics.

According to Gardner and cols[17], 5-30% of the improvement is explained by the hemodynamic variables of the AAI and blood flow in the leg. The remainder (65-70%) would be associated to a better redistribution of the blood flow, better hemorheology, less dependence on the anaerobic metabolism, better oxygen use, and gait improvement (biomechanical efficiency).

Stewart and cols[8] divide the factors associated to the clinical improvement in two categories: “possible explanation” (increase in the endothelial vasodilating function, improvement of muscle metabolism, decrease of blood viscosity and systemic inflammatory response) and “less robust evidence” (increase of blood flow in the leg and increase of peripheral oxygen supply). Additionally, they state that there is no significant evidence for the exact quantification of how each isolated mechanism contributes for the observed improvement.

The main parameters analyzed (for improvement assessment) were: the distance of walking until the start of pain and distance until the maximum pain. The means of improvement observed in two important studies were 119% / 179% for the start of pain and 83% / 122% for the maximum pain[17,19].

Resistance exercises in PAD:

A clear difference with a smaller number of studies that used resistance exercises is observed in literature[8,18,19]. Such reviews show that this type of exercise is less effective than walking, with its indication being secondary and complementary.

Hiatt and cols[26] carried out a comparative study between resistance exercises and walking, which has been cited in large reviews[8,18-20]. The 29 study patients were divided in three different groups: resistance exercises (3 times a week, 5 exercises for different muscle groups of lower limbs, 6 maximum repetitions, for 12 weeks), walking (3 times a week, one hour, moderate intensity, on a treadmill, for 12 weeks) and initially inactive control group.

After the initial 12-week period, the walking group continued with the training for additional 12 weeks. The resistance exercise group initiated the walking protocol and maintained it for 12 weeks. The control group, from the initially inactive status, initiated a combination of exercises (resistance + walking) also for 12 weeks.

The results presented at the end of the study showed a clear advantage for the walking group when compared to the resistance exercise group (74% *versus* 36% in the increase of distance of the maximum pain when walking).

However, despite the advantage presented by the walking group, the resistance exercises promoted an increase of strength within 12 weeks (17% in the more and 13% in the less severely affected leg, approximately), which was observed in this group, only. The acquired strength was partially lost at the end of the 24-week study period, when the resistance exercise group completed the 12-week walking protocol.

The combined training group did not disclose increase in muscular strength, but attained improvement of performance that was similar to the walking group.

An arm of the study was previously published by Regensteiner and cols[27] assessing, also comparatively, other focal points. In this study, the resistance exercises were more effective regarding the walking velocity, capacity of climbing stairs and improvement of the general well-being parameters.

Another study[28], by Hiatt and cols, when assessing aspects of muscular metabolism, did not observe changes in the muscular histology and the metabolism of carnitine, but there was a decrease in the activity of the enzyme citrate synthase.

Mc Guigan and cols[29] studied the muscular alterations caused by resistance training in 29 patients with PAD (3 times a week, 2 series per exercise, 8 types of exercises including lower limbs and abdominals, 8-15 maximum repetitions for 24 weeks). As a result, the study not only presented an increase in muscular strength (155% in leg press and 126% in the calf muscle) and increase in the capillarization (18%), but also improvement in the deambulation capacity similar to the values obtained with walking (158% vs. 119%[19] – 179%[17]).

The percentage increase of muscular fibers type IIa (25%) and improvement of function and hypertrophy of the other fiber types (type I: 28% and type IIa/b: 24%) in the presence of chronic ischemia was reported and related to the increment of walking patterns, attained through training.

Two other[53,54] previously cited[19] studies used resistance training and presented increase in the distance to the start of pain when walking (97-179%) and maximum distance of pain when walking (91-151%), also similar to the mean values obtained with walking[19,17].

Discussion

In spite of the information available in aforementioned studies, it is necessary to make some considerations about the terminology used in some of them[9,50]. These studies classify walking as "aerobic exercise", which is contradictory regarding the fact that in PAD, there is a decrease of blood flow and consequently, of the oxygen supply to the musculature (that is exacerbated by exercise), which in turn generates increases in local acidosis (anaerobic metabolism), causing patients to stop the exercise due to pain and fatigue a few minutes after initiating it.

A more correct form forma (used since the beginning of this text) would be "walking exercises" or simply "walking", which avoids the discussion regarding the energy production pathway utilized.

Although healthy people can perform this type of exercise with low intensity (small load) and continuously (interrupted only at the end of the session), with most of the energetic production being supplied by the aerobic pathway[55], the same is not true regarding those individuals with PAD, who end up "walking anaerobically", being forced to intercalate the training session with resting periods to relieve the symptoms caused by claudication.

The exercises performed with some type of resistance (usually weights) are called "resistance exercises", and these can aim at developing maximum muscular strength, power, hypertrophy and endurance[55]. A specific training program is employed for each intended aim, where the resulting adaptations will thus be direct consequences of the chosen method (Chart 5).

Individuals whose training includes heavier weights and a lower number of repetitions[1-6] tend to present higher gains of hypertrophy and maximum muscular strength, whereas those whose training includes lighter weights and a high number of repetitions[15-20] tend to higher gains in prolonging submaximum efforts (metabolic adaptation) and increase in capillarization, without muscular hypertrophy[56,57].

Chart 5
Adaptations to strength training according to the number of repetitions[30].

RM 3 6	10 12		20 25
Strength/power	Strength/power	Strength/power	Strength/power
Resistance at high intensity	Resistance at high intensity	Resistance at high intensity	Resistência at high intensity
Resistance at low intensity	Resistance at low intensity	Resistance at low intensity	Resistance at low intensity
Maximum power production	← Until →		Low power production

As for the intermediate groups to the ones cited above, (8-12 repetitions and moderate weights) adaptations of strength and hypertrophy similar to those seen in the first group and a tendency to increase capillarization similar to the second group are observed, thus configuring a mixed picture of adaptations in the presence of resistance training[56,57].

Hiatt and cols[26], in their frequently cited study, presented methodological features that deserve to be considered:

1) The patients were not limited to performing only walking exercises or only resistance exercises. They were encouraged to perform activities on the other subsequent days that were not study days. The latter were neither controlled nor recorded for the comparative analyses.

2) On occasion, body and ankle weights were used, which could have compromised the intensity of the exercises.

3) When on combined training (12 weeks) after a 12-week period as control group, the patients performed 90 minutes of exercises (60-min walking, followed by 30 min of resistance exercises), which could have resulted in excessive training time per session, compromised intensity due to earlier fatigue and antagonist muscular adaptations according to the principle of specificity suggested by the training.

4) Six maximum repetitions (MR) were performed per muscular group, following an order of five groups, with resting and repetitions periods of the same order (circuit). Thus, in addition to the fact that the 6 MR generate mainly strength adaptations in detriment to muscular endurance, the requested group would present quite long intervals, with a likely impairment of the efficacy of this exercise.

5) The progression of loads was carried out according to the patients' fortnightly assessment and not according to the constant (per session) evaluation, which could have again impaired the intensity of the exercise.

6) Five-minute warm-up as well as 5-min cool-down activities were performed, totaling 10 minutes of activities that are not resistance exercises.

The same considerations can be extended to the results disclosed by other previously published studies carried out by the same group of researchers[27,28].

Mc Guigan and cols[29] used an ergometric bicycle for warm-up and cool-down exercises, totaling 6 minutes of continuous exercises per session, which, in theory, could have compromised in part the results attributed to resistance exercises only.

The recently cited studies[19,53,54] do not describe the methodology of the resistance exercises used in training, as well as the fact that part of the training was carried out at the patients' houses and away from supervision, with a possible impairment of the efficacy and incorporation of concurrent walking exercises. Therefore, the significant results presented by such groups cannot correspond to the actual therapy efficacy attributed to resistance exercises.

Conclusion

We see a gap in literature regarding the use of resistance exercises in PAD as an isolated form of therapy. This adds to the absence (known by us) of studies that used resistance exercises aiming at improving muscular endurance, an objective that would also be indicated for the elderly affected by the disease.

It remains to be determined what all the variables are as well as their influence as the cause or consequence of the muscular observations that are characteristic of those affected by the disease. Hence, according to our observations, further studies with resistance exercises are warranted, considering the scarce investigation of the variants in this type of training and its possible adaptations.

For those patients who cannot or should not walk or simply do not like walking, resistance exercises constitute a good potential source of treatment, due to a possible alteration and reversion of the muscular characteristics of PAD, as shown by Mc Guigan and cols.[29], according to our considerations.

This type of training can be carried out safely even by elderly patients and those who present miscellaneous associated pathologies.

Finally, as resistance exercises act predominantly on the two main physical skills related to the good performance of daily living activities (strength and flexibility), they must be further investigated and compared, in order to confirm or contest the efficacy of this type of treatment aiming at promoting health and a better quality of life for elderly patients with PAD.

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