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ARTIGO DE REVISÃO

Avaliação da função muscular em doença arterial obstrutiva periférica: a utilização da dinamometria isocinética

Assessment of muscular function in peripheral arterial obstructive disease with the use of isokinetic dynamometry

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RESUMO

Indivíduos com doença arterial obstrutiva periférica apresentam perda funcional, principalmente em membros inferiores, gerando prejuízo da capacidade de caminhada. Os testes de caminhada são rotineiramente utilizados para avaliação e seguimento desses pacientes. Em pacientes idosos, com comorbidades e limitações associadas à claudicação intermitente, torna-se difícil a avaliação pela caminhada, principalmente nos casos de doença bilateral com acometimento desigual, onde o membro mais afetado limita a avaliação do menos afetado. A avaliação muscular isocinética é uma metodologia alternativa aos testes de caminhada para avaliar de forma individualizada as perdas funcionais geradas pela doença nos diferentes grupamentos musculares em territórios isquêmicos.

PALAVRAS-CHAVE

doenças vasculares periféricas, fadiga muscular, força muscular

ABSTRACT

Individuals with peripheral arterial obstructive disease present functional deficits, mainly in the lower limbs, generating an impaired walking capacity. In order to assess this deficit and ambulatory follow-up, walking tests are routinely used. In elderly patients, who present associated multiple and limiting comorbidities, in addition to the symptoms of intermittent claudication, the evaluation by walking tests becomes difficult, mainly in cases of bilateral disease with different affection, where the more severely affected limb limits the evaluation of the less severely affected one. The muscular isokinetic assessment is an alternative method to individually evaluate the disease-generated deficits of the different muscular groupings in ischemic territories, thus overcoming the difficulties and deficits presented by patients at the walking tests.

KEYWORDS

peripheral vascular diseases, muscle fatigue, muscle strength

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INTRODUCTION

As the world's elderly population increases in proportion to other population age ranges, the incidence of degenerative chronic diseases also increases, indicating a mean of 3.5 diseases per elderly outpatient.[1]

The peripheral arterial obstructive disease (PAOD), a complication of systemic atherosclerosis that affects the vessels after the aorta bifurcation, also increases its incidence[2,3] with aging, varying from 6.6 (55 years) to 52% (85 years).

One of the main clinical manifestations is the intermittent claudication, which is characterized as muscular pain or cramps, burning or tingling sensation in the lower limbs (uni- or bilaterally, affecting different muscular groups) when ambulating. The intermittent claudication prevents the gait maintenance and improves with rest.[4,5] Patients with PAOD present histological and functional alterations in the ischemic territories.[6]

Stewart *et al*, in 2002, verified that patients affected with PAOD presented decrease in muscular mass with atrophy and denervation of type IIa fibers, also known as fast-twitch oxidative glycolytic fibers, decreased nervous conduction function, muscular metabolism alteration and endothelial dysfunction, decreased muscular strength and endurance and impaired walking capacity, increasing physical deconditioning and sedentarism, similarly to the sedentary elderly, but at higher degrees.[7]

The diagnosis of PAOD is attained clinically and confirmed by the measurement of the ankle-arm index (usually presenting < 0.90) and by imaging studies.[4]

In order to objectively evaluate the gait impairment, several walking tests are used according to previously validated protocols in an ergometric treadmill[8] or lane.[9] However, although the tests are more often used and provide objective data on the functional limitation of the patients, we have observed (data not published) that they fail in two situations of ambulatory practice: 1) when the patients have other limitations (associated cardiorespiratory diseases, such as coronariopathies, severe heart or respiratory failure, degenerative locomotor system alterations such as incapacitating arthroses or use of orthosis; and the lack of motor skill to use ergometers); 2) when the patient presents bilateral disease and one of the limbs has a more severe ischemia, generating an early limitation in gait assessment, making it difficult to perform an accurate evaluation of the less severely affected limb.

Therefore, the use of the isokinetic dynamometry has been suggested for patients affected with PAOD, especially those patients that somehow cannot or are incapable of ideally performing the functional and physical aptitude evaluation through walking tests.[10-19]

LITERATURE REVIEW

Research sources and methods:

A cross-section of terms was carried out at the electronic database of PUBMED. Three terms were related to muscular assessment ("isokinetic", "muscular strength" and "muscular endurance") and ten terms were related to peripheral arterial obstructive disease ("intermittent claudication", "peripheral arterial disease", "peripheral vascular disease", "arterial occlusive disease", "peripheral arterial occlusive disease", "peripheral arterial insufficiency", "chronic arterial insufficiency", "chronic occlusive arterial disease", "chronic vascular occlusive disease" and "claudication pain").

There were no limits for the search.

A total of 30 cross-sections was possible using the words described above. Of these, 47 study abstracts were collected, where some studies appeared several times at different cross-sections.

After this first step, when the repeated studies were excluded and the remaining abstracts were read, only the studies carried out with human subjects that dealt with PAOD and isokinetic dynamometry were selected, with a final result of only 4 studies. Subsequently, another 5 studies were included in the literature review that had been found at a previous review,[20] related to physical exercises for patients affected with PAOD, where isokinetic dynamometry was used in the evaluations. One last study found at the thesis database of the Library of the School of Medicine of the University of Sao Paulo (FMUSP) was also included.

For the references of the selected studies, a search in the complete journals was carried out through the websites of the electronic journals "Portal da Pesquisa" (www.portaldapesquisa.com.br), and "SIBI" (www.usp.br/sibi). A complete search was also carried out through the BIREME library.

Isokinetic Muscular Assessment:

This is a type of muscular evaluation and functional balance assessment of the locomotor system, using an isokinetic dynamometer.[21] Different parameters are used and the results are evaluated in the comparison with the contralateral limb and by the muscular agonist-antagonist ratio.[22] The isokinetic dynamometer has levers with axes that adjust to the axes of each tested joint and concentric as well as eccentric contractions can be performed.[22] The equipment maintains a constant angular velocity (measured in degrees per second) of the movement and allows the segment assessment under dynamic conditions,[23,24] thus all force applied to the equipment by the muscle being tested receives equal and opposite resistance,[22,23] allowing the analysis of the segment throughout the entire range of movement.[24]

Several velocities are used, varying from 30 to 300º/sec. Velocities > 180º/sec are used to evaluate muscular strength.[24]

The most frequently used parameters of analysis are: [22-24]

"*Torque peak*", which is the point of highest torque (force x distance) in the range of movement, measured in Newton/meter (N/m). The lower the velocities selected at the assessment, the lower the measured torque will be.

"*Work*": Energy spent during the muscular effort during the movement, measured in Joules (J). The lower the velocities selected for the test, the higher the work will be.

"Power": The measurement of work (J) divided by time (sec), presented as Watts (W). The higher the selected angular velocity, the higher the measured power will be.

"Agonist-antagonist balance ratio": which consists in the

division of the value obtained for the agonists by the antagonists, being related to the Torque peak, Work or Power. It is expressed as a percentage (%) value.

"Index of Resistance": proportion of the final half over the initial half (of the estimated number of repetitions), expressed as a percentage value (%), which represents the energy used by the anaerobic metabolism.

"Acceleration time": time necessary to reach the angular velocity that was previously selected for the test.

Isokinetic Muscular Assessment in PAOD:

Gerdle et al[10] carried out the first study in 1986 that involved isokinetic assessment. The authors evaluated 24 patients and 15 sedentary controls regarding the torque peak and total work. The results showed values that were 20% to 25% lower in plantar flexion power at all angular velocities (30,60,120 and 180 º/sec), when the controls were compared to the ischemic limbs.

The analysis of muscular fatigue during the plantar flexion (200 repetitions at 60º/sec.), showed a clear difference at the end of the first 40 repetitions, where there was a decrease of 50% in torque peak and 55% in total work for patients affected with PAOD in relation to controls (13% and 18%, respectively). The authors also verified a positive correlation between the total work measured and the maximum distance walked on the treadmill.

Hedberg et al,[11] in 1988, comparatively assessed the effects of exercise training or surgical treatment in patients with PAOD. This study had no disease-free control group, which prevented the comparison between the results obtained by patients and controls regarding the differences in muscular strength and fatigue before the interventions.

Regensteiner et al[12] in 1993, evaluated 26 patients and 6 sedentary controls, assessing plantar flexion and dorsiflexion. At the assessment of the muscular strength (best of two attempts of a protocol with 5 repetitions at 60º /sec) of the gastrocnemius and anterior tibial muscles (plantar flexion and dorsiflexion) of patients with PAOD, they observed a decrease of 43% and 31% (respectively) in torque peak in relation to controls. They also verified a decrease of 38% in muscular performance (number of repetitions made at 240º/sec, necessary to observe a decrease of 50% in torque peak) of the gastrocnemius muscle (plantar flexion). In this study, the muscular strength was positively correlated with the maximum walking distance.

Hiatt et al[13] in 1994 evaluated the result of different types of training on muscular strength and fatigue, using isokinetic evaluation. However, this study showed only the positive interference of the performed trainings on the mentioned variables, without specifying whether patients with PAOD presented, initially, functional alterations in relation to disease-free individuals.

Hiatt et al[14] in 1996, at the evaluation of the positive effects of power training or treadmill walking on muscular histology and metabolism, did not report at the initial data whether there were differences in muscular strength and fatigue between individual with and without PAOD.

In a study to evaluate the muscular strength of 31 elderly patients with PAOD and 15 controls, Scott-Okafor et al,[15] in 2001, reported a decrease in the isometric force of the legs of 22% when compared to the control group. Among the affected individuals, the more severely affected leg presented a deficit of 15% of strength in relation to the less severely affected leg. This study showed no statistically significant difference in knee flexion and extension or hip extension (although those affected by the disease presented a deficit of 14%, with a difference of 7% regarding the most affected *vs*. the less affected side).

Askew et al,[16] in 2003, using a protocol of increment of progressive intensity for muscular strength evaluation (strength and resistance) of the gastrocnemius muscle in 16 elderly patients with PAOD and 13 controls, observed a decrease of 25-59%. These data were positively correlated with the maximum walking distance on the treadmill and performance on an ergometric bicycle.

Demonty et al,[17] in 2004, carried out a study for a comparative isokinetic evaluation in 10 individuals with PAOD and 10 sedentary controls. The results of the strength assessment in the plantar flexion and dorsiflexion (using 3 series of 5 movements at 120º/sec, followed by 3 series of 3 movements at 30º/sec, noting the highest value obtained at the last ones) showed decreased muscular strength values that varied from 24% to 50% in those affected by the disease. The fatigue assessment (20 repetitions performed at 180º/sec) of the dorsal extensors and right and left plantar flexor muscles in those individuals affected with PAOD showed a decrease in performance that varied from 27% to 61% in comparison to the sedentary controls.

Nakano et al,[18] in 2006, carried out a study to evaluate claudication of upper limbs and comparatively assessed 23 individuals with subclavian arterial occlusive disease and 7 controls. The authors reported a significant decrease in the total number of repetitions (maximum of 270 repetitions, divided in series of 30 with a 5-second interval between them) and of the total work during the isokinetic test, when comparing the affected individuals and controls (56% and 60%, respectively).

Basyches[19] comparatively measured the maximum torque (force) and the total work (resistance), between ischemic and non-ischemic limbs of 22 individuals with unilateral PAOD who presented intermittent claudication. To evaluate the aforementioned parameters, 60 repetitions with an angular velocity of 120º per second were used. The results showed that there was no significant difference between the assessments, suggesting that PAOD does not influence such parameters (muscular strength and resistance).

The results of this study differ from previously reported ones,[10,12,15-18] which verified the negative influence of PAOD on the muscular strength and fatigue parameters, with two hypotheses being proposed by the author for the results obtained: 1) A better efficiency of the musculature as a result of the adaptation to the chronic ischemic stimulus; and 2) Test with an insufficient stimulus to promote a significant decrease in the assessed parameters, given the small number of repetitions.

Safety of the isokinetic muscular assessment:

From the point of view of safety during the test performance,

Katsiaras et al, [25] carried out a large study and evaluated the muscular resistance in 1,572 elderly individuals (70-79 years), with no reports of intercurrent events during or after the procedure. Aquino et al[26] evaluated the strength of the knee joint extensors and flexors, also in an elderly population (75-83 years), to establish normal parameters for comparison with possible diseases, with no reports of intercurrent events in any of the evaluations.

In patients with PAOD, who in their majority have multiple associated risk factors (cardiovascular and cerebrovascular disease, systemic arterial hypertension, diabetes and dyslipidemia),[5] the isokinetic assessment maintains the patterns of heart rate (HR) and blood pressure (BP) within ranges considered to be significantly low (66% of the maximum HR and a systolic BP of 160mmHg immediately after the test).[17,18]

The only report of Angina Pectoris during the isokinetic assessment was made by Hedberg et al[11] in 1988, reporting two patients.

CONCLUSION

The use of an alternative method to evaluate muscular function through isokinetic assessment in individuals with PAOD has been little studied, with a small number of publications available in the literature and still controversial results, suggesting the need to further test the method.

The use of this type of assessment allows a large number of variations and possibilities in its methodology, when evaluating muscular function in the different limbs and their possible differences.

Different tested joints and velocities used to assess muscular strength and resistance, as well as reliability and reproducibility of the measurements in this specific population have yet to produce a consensus in the literature and need further investigation.

The characteristics of the affected population observed in the study are very heterogeneous, varying mainly regarding the age, time and severity of the disease, level of obstruction to flow, used medications, risk factors, associate comorbidities and level of physical activity. This heterogeneity of the study population and the different methods used in the isokinetic assessment hinder the qualification and the quantification of a possible deficit that is consequent and/or restricted to PAOD.

Thus, despite the controversial evidence that the affected individuals presented some degree of functional deficit and that this type of assessment was carried out safely in this population, further studies will be necessary to increase the reliability of this evidence, confirming or contesting the obtained data.

In the future, such studies will also be useful to create a more individualized classification for clinical follow-up, necessity of treatment or surgical intervention in the affected individuals, considering the different levels of muscular functional deficit and the different limbs (affected or non-affected) .

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