Influence of muscle strengthening in the balance and quality of life in individuals with Parkinson's disease

Influência do fortalecimento muscular no equilíbrio e qualidade de vida em indivíduos com doença de Parkinson

Influencia del fortalecimiento muscular en el equilibrio y calidad de vida en individuos con enfermedad de Parkinson

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ABSTRACT | This study aimed to evaluate the effect of muscle strengthening in the balance, mobility and quality of life (QoL) in individuals with Parkinson's disease (PD), and to check the correlation between muscle strengthening and QoL. Nine subjects belonging to both sexes, diagnosed with PD, participated in this study. Initially, they went through an evaluation of their balance and functional mobility through the Berg Balance Scale (BBS), the *Timed Up and Go* (TUG) test, and a QoL test through the *Parkinson's Disease Questionnaire (PDQ-39)*. The subjects also performed a test for determining the maximum load (one-repetition maximum) for the muscle groups trained. After the normality and homogeneity of the data were verified, the Student's *t*-test and Spearman correlation test were carried out. A significance level of $p<0.05$ was considered. We verified an improvement in balance ($p=0.008$) and QoL ($p=0.013$), and a negative correlation between balance and QoL (evaluation: $r=-0.65$ and $p=0.05$, revaluation: $r=-0.82$ and $p=0.005$). It was concluded that muscle strengthening was efficient in the improvement of balance and QoL in individuals with PD.

Keywords | Parkinson disease; quality of life; balance.

RESUMO | Esse estudo teve como objetivo avaliar o efeito do fortalecimento muscular no equilíbrio, mobilidade e na qualidade de vida (QV) de indivíduos com doença de Parkinson (DP), e verificar a correlação entre fortalecimento muscular e qualidade de vida. Participaram do estudo nove sujeitos, de ambos os sexos, com diagnóstico médico de DP. Eles, inicialmente, passaram por avaliação do equilíbrio e da mobilidade funcional por meio da Escala de Equilíbrio de Berg (EEB) e teste *Timed Up and Go* (TUG) e da QV pelo questionário *Parkinson's Disease Questionnaire (PDQ-39)*. Os sujeitos realizaram ainda o teste de determinação de carga máxima (1 RM) para os grupos musculares treinados. Depois de verificadas a normalidade e homogeneidade dos dados, foram realizados o teste *t* de Student e o teste de correlação de Spearman. Foi considerado nível de significância de $p<0,05$. Foi verificada melhora no equilíbrio ($p=0,008$) e na QV ($p=0,013$), e correlação negativa entre equilíbrio e QV (avaliação $r=-0,65$ e $p=0,05$; e na reavaliação $r=-0,82$ e $p=0,005$). O fortalecimento muscular foi eficaz na melhora no equilíbrio e na qualidade de vida de indivíduos com doença de Parkinson.

Descritores | doença de Parkinson; qualidade de vida; equilíbrio.

RESUMEN | Este estudio tiene como objetivo evaluar el efecto del fortalecimiento muscular en el equilibrio, movilidad y en la calidad de vida (CV) de individuos con Enfermedad de Parkinson (EP), y verificar la correlación entre el fortalecimiento muscular y calidad de vida. Participaron del estudio nueve sujetos, de ambos sexos, con diagnóstico médico de EP. Inicialmente los sujetos pasaron por una evaluación del equilibrio y la

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movilidad funcional por medio de la Escala de Equilibrio de Berg (EEB) y el test Timed "Up and Go" (TUG), y de la CV por el cuestionario *Parkinson's Disease Questionnaire (PDQ-39)*. Los sujetos realizaron también el test de determinación de carga máxima (1 RM) para los grupos musculares entrenados. Después de verificar la normalidad y homogeneidad de los datos fue realizado el *Test t de student* y el test de correlación de Spearman. Fue considerado nivel de significancia de p<0,05. Fue verificada una mejora en el Equilibrio (p=0,008) y en la CV (p=0,013), y correlación negativa entre el equilibrio y CV (evaluación r= -0,65 y p=0,05; y en la reevaluación r=-0,82 p=0,005). El fortalecimiento muscular fue eficaz en la mejora del equilibrio y en la calidad de vida de individuos con enfermedad de Parkinson

Palabras clave | enfermedad de Parkinson; calidad de vida; equilibrio.

INTRODUCTION

Parkinson's disease (PD) is the second most common neurodegenerative disease[1] and affects people mainly starting from their fifth decade of life, with an exponential increase in the elderly between 65 years and 90 years of age[2,3]. With the progression of PD, individuals show progressive disturbances in balance, posture and gait[4], mobility, as well as losses in the performance of daily activities[5,6]. According to Nocera et al.[7], individuals often show reduced muscle strength and postural instability, which increases their risk of falls.

Such functional compromises generate losses in the quality of life (QoL), limit functional independence, and cause isolation or lack of participation in social life[4-6]. Schestatsky et al.[8] reported in their study that the decrease in the QoL of PD patients is related to the duration and severity of the disease, so those who are in the later stages of the disease have a worse QoL.

Physical therapy becomes necessary at the initial stages of the disease, minimizing and delaying its evolution, and hence seeks to provide a better QoL and functionality to patients[9,10]. Pereira et al.[11] conducted a study with a group of PD patients and found significant improvement in functional mobility, balance, and functionality after 35 sessions of physical therapy. Brichetto et al.[12] observed an improvement in gait and QoL in PD patients after six weeks of treatment.

Several studies have demonstrated the relationship between muscle strength, postural stability, and performance in functional tasks, in the elderly and in people with disabilities[13,14]. There are studies in the literature that indicate benefits of resistance training in gait[15] and balance[7] in patients with PD. Studies also suggest beneficial effects on functional performance[16] and QoL[17] through strengthening programs associated with aerobic exercise, in individuals with PD. However, the effects of the exclusive use of muscular strengthening in functionality and mobility, as well as their influence on the QoL of individuals with PD, remain unclear.

This study aims to determine the effect of muscle strengthening on balance, functional mobility, and QoL in individuals with PD and verify the correlation between muscle strength and QoL.

METHODOLOGY

Participants

Participants were individuals diagnosed with PD, classified between stages 1 and 3 of the Hoehn & Yahr Modified Scale, which describes mild to moderate disability[18]. Individuals were capable of walking independently, had no other associated neurological disease, and did not undergo modifications in drug treatment during their participation in the study.

To analyze the results, it was necessary for the volunteer to attend at least 75% of the sessions. In the present study, all volunteers had a greater attendance rate than the established.

This study was approved by the Ethics Committee of the Institution where this study was performed (CEP-0052/2011).

PROCEDURES

Evaluation

Initially, an interview was conducted individually with each participant to characterize the sample, obtain personal data, and identify the inclusion criteria.

Before and after the end of the strengthening program proposed, subjects underwent an evaluation of balance, functional mobility, and QoL.

Evaluation of balance

For the evaluation of balance, the Berg Balance Scale (BBS) was used. BBS is an instrument validated by Berg et al.[19] and culturally adapted to Brazil[20].

The BBS consists of 14 tasks involving static and dynamic balance. The evaluation is made by observation and the score ranges from 0 to 4, which can total 56 points. According to Shumway-Cook and Woollacott[21],

in the range of 56 to 54, one point less is associated with an increase of 3% to 4% below the risk of falls, from points 54 to 46, the change in one point is associated with an increase of 6% to 8% chance, and below 36 points, the risk of falling is almost 100%.

Evaluation of functional mobility

For the evaluation of functional mobility, the Timed Up and Go (TUG) test was used. Factors analyzed were the time spent by the individual to rise from a chair with arms, walk a distance of three meters (approximately 10 ft), and return to the chair. Larger time values represented a greater risk of falls[22].

What authors consider a normal performance for healthy adults is an interval of up to 10 s; for the frail elderly and the disabled who tend to be independent for most daily activities, an interval between 10.01 s and 20 s is considered normal. However, when an interval above 20.01 s is spent to perform the task, a more detailed evaluation of the individual is required to assess the degree of functional impairment[23].

Evaluation of the QoL

The evaluation of the QoL was obtained through the Parkinson's Disease Questionnaire (PDQ-39) from the Health Services Research Unit of the University of Oxford, validated to English[24] and adapted to Brazilian Portuguese (Health Services Research Unit) in 2005.

The PDQ-39 consists of 39 items that can be answered with one of five different options: "never", "occasionally", "sometimes", "often", and "always" or "cannot do it at all"[25]. Scores on each item range from 0 (never) to 4 (always or cannot do it at all). The total score on the PDQ-39 ranges from 0 (no problem) to 100 (highest level of problem), i.e. the higher the score, the worse the person's perception of their QoL.

Test for determining maximum load

All volunteers underwent a one-day adaptation to the exercises the day before the beginning of the test to determine the maximum load or one-repetition maximum (1 RM). The exercises were conducted for the following muscle groups: knee flexors, quadriceps, hip adductors, hip abductors, pectorals, biceps, and triceps.

Prior to the beginning of the attempts to determine the 1 RM, volunteers performed a series of 20 repetitions of specific warm-ups, with a rather low load. After a five-minute resting interval, a load presumably close to the maximum capacity of the individual was added. If the first load was lower than the maximum and the voluntary would perform more than one repeat, a load higher than the previous one was added, and a five-minute resting interval was provided before the next attempt. On the other hand, if the volunteers could not perform a full repetition, a new attempt was given with a load lower than the previous one, after a five-minute resting interval. This test was continued until the volunteer could perform one single full repetition.

For each volunteer, the test to determine 1 RM was carried out for two muscle groups in alternate limbs (upper and lower) on each side of the body (left and right), per day, with a 30-minute resting interval.

Muscle strengthening program

The physical activity program was conducted twice a week for 12 weeks, with one-hour sessions, in a proper place for physical activity. For each muscle group, there were three sets of 10 repetitions. The exercises were performed in open kinetic chain using the following mechanotherapy appliances:

- Knee flexors and extensors – Leg extension/Leg curl bench
- Hip abductors and adductors – Hip adductor/abductor bench
- Horizontal shoulder adduction – Shoulder press bench
- Forearm flexors – Biceps curl machine
- Forearm extensors – Dumbbells

In the first, second, and third fortnights, volunteers trained with 30%, 40%, and 50% of the load reached during the test of 1 RM, respectively. In subsequent weeks, the load used was 60% of 1 RM.

For the final revaluation of each volunteer's muscle strength after the training program, we performed the 1 RM test. At the end of each month, the volunteers were tested again for 1 RM, and the absolute value of the training load was adjusted.

Blood pressure was monitored at the beginning and end of each session.

The evaluations and the muscle strengthening program were performed in the same period of the day for each participant, so that, during all procedures, individuals were on the same medication stage.

Statistical analysis

For statistical analysis, the GB-STAT software was used. Afterwards, to verify the normality and homo-

geneity of data, Student's *t*-test and Spearman correlation test (significance level of p<0.05.) were performed. The significance level was set at α=0.05.

RESULTS

Nine subjects (three men and six women) with a mean age of 69.5±9.1 years and mean disease progression time of 7.54±3.6 years, participated in the training.

Table 1 indicates the values obtained by the participants in the Berg, TUG, and PDQ-39 tests before and after muscular strength training.

Table 2 shows the results of the 1 RM test from the initial evaluation and from the final revaluation. It is possible to observe that there was a significant increase in strength for all muscle groups exercised.

After the muscle strengthening program, subjects showed improvement in balance (p=0.008) and QoL (p=0.013). Functional mobility was not affected by the proposed training (p=0.19).

The correlation analysis showed a significant correlation between balance and QoL (evaluation: r=–0.65 and p=0.05, revaluation: r=–0.82 and p=0.005). The other variables showed no significant correlation.

DISCUSSION

In our study, we observed a deficit in balance in the initial evaluation (BBS=45.77±5.2), which indicates that the participants presented an elevated 6–8% chance of falling[21]. With muscle strength training, there was a significant improvement in the balance of individuals (BBS=48.44±4.1, p=0.008).

Studies show that there is a positive correlation between changes in balance and decreased muscle strength[26-28]. According to Shepherd[29], the muscle strengthening exercises work on increasing the recruitment of motor units, improving the body balance, ability and timing to generate force, reducing muscle stiffness and reflex hyperactivity, and preserving functional muscle extensibility. Rodrigues-de-Paula et al.[16] reported that gaining muscle strength through an adequate training program is effective in conditioning and maintaining balance, preventing falls that are, when aggravated by balance disorders, common in these individuals.

In the TUG test, the results obtained in the evaluation (19.81±4.4 s) are considered normal for the frail elderly and the disabled who tend to be independent for most daily activities[23]. With the increase in muscle strength, the test showed no significant difference (17.88±7.4 s, p=0.19). This could be due to the fact that one of the main features of PD is the slowness of movements[11], and the proposed training program emphasized just muscle strengthening, and not movement speed. In the study conducted by Morris et al.[30], the primary deficit related to the slowness of gait in PD was a disorder in the regulation of step length as the regulation was in preserved cadence (number of steps per minute).

Regarding QoL, significant improvement was observed after the proposed training (p=0.008). Studies by Reuter et al.[31] and Baatile et al.[32] showed significant improvements in QoL for PD patients with mild to moderate severity after undergoing physical activity programs. Reuter et al.[31] conducted an exercise program twice a week for 14 weeks, aiming at muscle strengthening, in addition to decreased stiffness of the torso and the improvement of movement initiation, and observed significant differences after

Table 1. Values obtained in the Berg, Time Up and Go, and Parkinson's Disease Questionnaire-39 tests in the initial evaluation and in revaluation

	Evaluation (mean±SD)	Revaluation (mean±SD)	p-value
BBS (points)	45.77±5.2	48.44±4.1*	0.01*
TUG (seconds)	19.81±4.4	17.88±7.4	0.19
PDQ-39	51.15±19.6	32.98±15.7*	0.008*

BBS: Berg Balance Scale; PDQ-39: Parkinson's Disease Questionnaire-39; SD: standard deviation; TUG: Time Up and Go; *Student's *t*-test: p≤0.05

Table 2. Values of muscular fitness in the one-repetition maximum test (in kg)

Muscle group	Evaluation (mean±SD)	Revaluation (mean±SD)	p-value
Knee flexors	5±2.29	9.55±5.05	0.001*
Quadriceps	12.77±9.39	19.55±12.17	0.004*
Hip adductors	47.22±23.59	58.88±18.33	0.001*
Hip abductors	13.11±10.21	18.44±10.58	0.001*
Pectoral	8.25±7.00	12.25±7.30	0.006*
Biceps	6.55±3.60	10.66±4.94	0.001*
Triceps	5.42±2.07	8.28±3.68	0.003*

SD: standard deviation; *Student's *t*-test: p≤0.005

the training period. The results were followed-up for up to six weeks after the end of the program.

In our study, we analyzed the correlation between the scores obtained in the PDQ-39 and the result of the BBS, in both the evaluation and the revaluation. An inversely proportional correlation was observed in the tests, suggesting that the lower the score on the PDQ-39, which indicates a better QoL, the higher the score in BBS, which indicates a better balance. Thus, we can infer that the better the balance, the better the QoL (evaluation: r=–0.65 and p=0.05, revaluation r=–0.82 and p=0.005).

According to Mak and Pang[33], the consequences caused by the incidence of falls, which reaches 68% in these patients, due to the deficit in their balance, increase the risk of immobility, social isolation, and depression, and thus decrease their QoL. Another importance of preventing falls is the fact that femur fracture is one of the main results of these falls, contributing to a greater restriction of activity and loss of independence in daily activities[34].

The proposed training program is efficient as it was capable of increasing strength in all muscle groups trained. It is of utmost importance to maintain and/or increase muscle strength in individuals with PD since, according to Scandalis, Bosak e Beliner[15], decreased muscle strength occurs effectively in PD patients. The weakness resulting from the disease leads individuals to feel insecure in carrying out daily activities, limiting them to the strictly necessary activities, generating greater muscle atrophy and consequent decrease in strength.

Despite the important findings, this study presents limitations, such as the small number of subjects and the lack of a control group. Moreover, we suggest new studies that will conduct evaluations after a period of detraining as it would provide information with regard to the maintenance time and the benefits of muscle strengthening after the end of the program. Still, it would be relevant to examine the subjects' history of falls before and after the treatment since individuals with PD have an increased risk of falls.

The results of this study showed that the physical activity program based on a muscle strengthening program was effective in improving muscle strength, balance, and QoL in individuals with PD. The score on the QoL scale had an inversely proportional correlation to the result obtained in the BBS, showing that the better the balance, the better the QoL of these individuals.

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