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Does the elbow position change the handgrip strength in Parkinson's disease?

A posição do cotovelo altera a força de preensão manual na doença de Parkinson?

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Abstract – The flexed elbow is a standardization position on the handgrip strength test, however the literature shows divergence in the values obtained from extended elbow. The aim of this study was to verify if there is such difference in people with Parkinson's disease. Cross-sectional study. Thirty-one elderly individuals with clinical diagnosis of Parkinson's disease, performed 2 handgrip tests, first with extended elbow and second with flexed elbow, with 48 hours of interval. There was not significantly different between positions for handgrip strength ($p > 0.05$). As well as, the effect size was insignificant ($d < 0.19$). The main results indicate there was no significant difference between the flexed and the extended protocol, the effect size was negative and very small, it shows there is no clinical effect. Since, there are no difference between elbow positions, The American Society of Hand Therapists standardized position is recommended for testing of handgrip strength.

Key words: Elbow joint; Muscle strength; Muscle Strength Dynamometer; Neurodegenerative disease; Elderly.

Resumo – *O cotovelo flexionado é uma posição padronizada no teste de força de preensão manual, no entanto, a literatura mostra divergências nos valores obtidos com o cotovelo estendido. O objetivo deste estudo foi verificar se existe tal diferença em pessoas com a doença de Parkinson. Estudo transversal. Trinta e um idosos com diagnóstico clínico da doença de Parkinson realizaram 2 testes de preensão manual, o primeiro com o cotovelo estendido e o segundo com o cotovelo flexionado, com intervalo de 48 horas. Não houve diferença significativa entre as posições para a força de preensão manual ($p > 0,05$). Além disso, o tamanho do efeito foi insignificante ($d < 0,19$). Os principais resultados indicam que não houve diferença significativa entre o protocolo flexionado e o estendido, o tamanho do efeito foi negativo e muito pequeno, o que mostra que não há efeito clínico. Portanto, não há diferença entre as posições do cotovelo, recomenda-se a posição padronizada da Sociedade Americana de Terapeutas de Mão para o teste de força de preensão manual.*

Palavras-chave: *Articulação do cotovelo; Força muscular; Dinamômetro de Força Muscular; Doença neurodegenerativa; Idosos.*

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INTRODUCTION

The measurement of muscle strength is important in studying health[1], aging[2], surgery[3] and disease[4], furthermore many diseases are characterized by the loss of muscle strength, these include Parkinson's disease (PD)[5], metabolic syndrome[6] and amyotrophic lateral sclerosis[7]. The handgrip dynamometer is widely used to assess muscle strength in healthy individuals[8], those who have injuries[9], those with neurodegenerative disease[8] including PD[5]. Handgrip strength (HGS) is the amount of static force that the hand can squeeze around a dynamometer[10], and it is an important prerequisite to adequate hand performance. Moreover, occupational and physical therapists often measure HGS of their patients in order to monitor their progress[11], and with the increasing severity of PD the individuals have weaker HGS[12]. To standardize progress, the American Society of Hand Therapists (ASHT) have standardized a protocol in which the individual is sitting with the elbow maintained flexed at 90º[13], but many factors may influence HGS[11], and one of them is elbow position[9].

Some investigators have chosen to compare 90˚ flexion with full extension because, when the elbow is flexed, the flexor *digitorium superficialis*, the only flexor muscle that crosses the elbow joint, is placed in a shortened position, which puts it at a mechanical disadvantage[11]. For example, Su et al.[14] found significantly higher grip strength was obtained in the full elbow extension for the dominant hand in healthy young individuals and elderly individuals. España-Romero et al.[15] found significantly higher grip strength was obtained in the full elbow extension for the right hand in adolescents. Oxford et al.[16] found that for both the dominant and nondominant hands, and regardless of the sex of the subject, grip strength is significantly greater when measured with the elbow in the fully extended position instead of 90˚ of flexion in both young and the healthy elderly. Kuzala and Vargo[17] found significantly higher grip strength was obtained in the full elbow extension for the dominant hand in healthy young individuals.

However, due to the inconclusive findings of the studies already carried out[11,14-16, 18], there is a gap in the literature about HGS in individuals with neural impairments, especially in people with PD[19]. Since weakness is a characteristic feature of the disease[5], we are interested in whether assessments of HGS do or do not depend on elbow angle, and this raises the question whether the greatest strength occurs in full extension in people with PD. Taken together, we hypothesized that the HGS generated with elbow in full extension would be significantly higher when compared to elbow flexed at 90º, therefore, the aim of the study was to analyze if there is difference in HGS in people with PD in two different elbow positions: ASHT protocol (flexed) and extended.

METHOD

Participants

Data are from 31 elderly individuals with clinical diagnosis of PD (22 men and 9 women) by a neurologist or physician, recruited in the exercise program from University of Brasília, with non-probabilistic sampling for convenience.

They were classified in one of four stages of modified Hoehn and Yahr scale[20]. The individual's dominance and the most affected side by the disease were not collected. Also, the patient's medications and disease diagnosis time were not collected.

The inclusion criteria were clinical diagnosis of PD by neurologist or physician, modified Hoehn and Yahr Scale classification between stages 1 and 3, controlled hypertension (<150/90 mmHg), do not have extreme obesity (>40 Kg/m^2), do not have a heart pacemaker, do not have amputation of upper or lower limbs, male and female, individuals between 40 and 80 years who do not have health problems and / or disabilities that prevent them from completing the test or who may have their problems aggravated due to participation in the test. The exclusion criteria were any kind of trauma that prevents participation in the study, inability to perform any the test, individuals who may voluntarily want to stop their participation in research, individuals who do not have availability to participate in the test.

The individuals were instructed to not perform physical exercises in the 24 hours prior to the test protocol, not to interfere with the test. The participants did two visits at University of Brasília with 48 hours of interval, the first for the extended elbow and descriptive measures. The second for the flexed elbow, and all participants was evaluated in "on" period of medication. The assessment was performed in both arms and the volunteer chose which hand to start the test. This study was approved by the ethics committee of the Faculty of Health Sciences at University of Brasília, and all subjects signed the informed consent form.

Descriptive measurements

The International Physical Activity Questionnaire short form was used to classify physical activity level[21]. In addition, weight and height were assess. The questionnaire was used to be able to have a heterogeneous sample in terms of physical activity.

Elbow positions

HGS was assessed with the JAMAR® hydraulic hand dynamometer (Patterson Medical, Warrenville, Illinois, USA). A trained and experienced researcher carried out all the evaluations of the volunteers. The JAMAR® dynamometer is an isometric tool with 5 fixed grip positions and precision of 2 KgF. The volunteers chose which hand to begin the test and better position of the fixed grip aiming for your comfort, and the principal investigator collected all HGS data. The highest value among all trials in each hand was used as the score.

Extended elbow: The first day of HGS assessment was conducted with the adapted protocol from Su et al.[14]. In this protocol the individual was seated on a chair without arm support, positioned with the shoulder in adduction and the elbow in full extension. The forearm in neutral position, the wrist position could vary from 0º to 30º of extension, as shown in Figure 1, and three measures were collected for each side. Rest interval was 60 seconds, and right and left arm strength was assessed alternately.

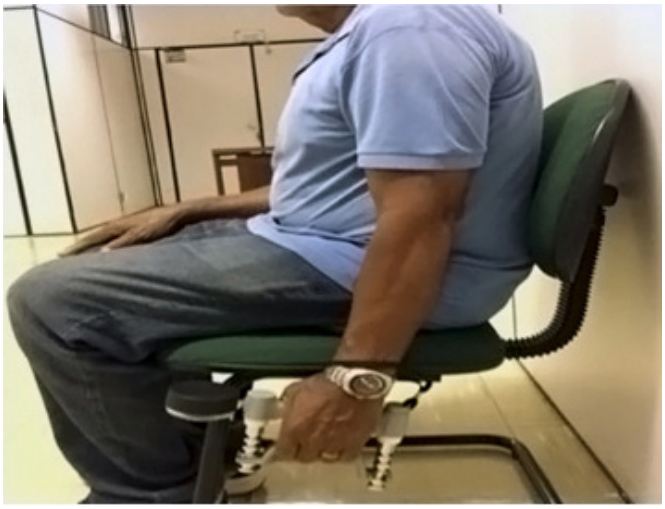

Figure 1. Extended elbow.

Flexed elbow: The second day of HGS assessment was conducted with the adapted protocol from ASHT[13], the individual was seated on chair without arm support, positioned with the shoulder in adduction and the elbow flexed at 90º. The forearm in neutral position, the wrist position could vary from 0º to 30º of extension, as shown in Figure 2, and three measures were collected for each side. Rest interval was 60 seconds, and right and left arm strength was assessed alternately.

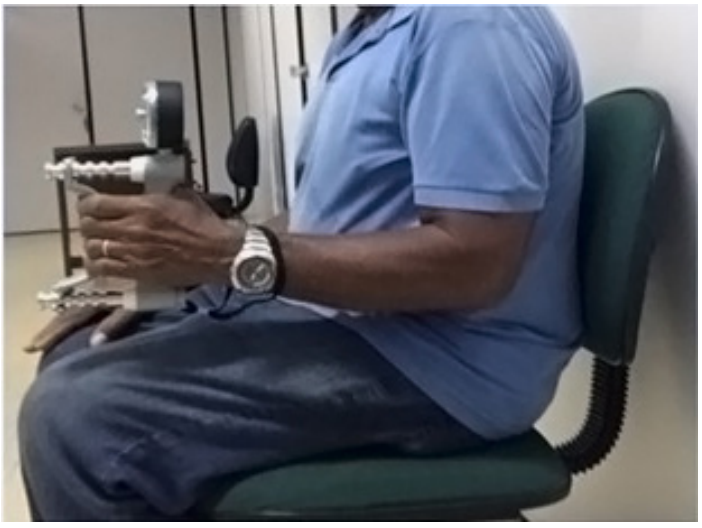

Figure 2. Flexed elbow.

Statistical analyses

Descriptive statistics were expressed as means, standard deviation and frequency. Comparisons between the flexed and the extended elbow positions for HGS were made using paired t-test and the clinical effect with Cohen's d statistic. A p-value of ≤ 0.05 was adopted. All analyses were performed using the SPSS 24 (IBM Corporation, Armonk, NY, USA, 24.0).

RESULTS

Table 1 shows the descriptive data of the subjects.

Table 1. Sample characterization.

	Mean ± SD
Age (year)	66.06 ± 8.48
Weight (kilogram)	71.84 ± 13.04
Height (centimeter)	168.97 ± 0.10
Gender (*f*)	(*f*)
Men	22
Women	9
Modified Hoehn & Yard (*f*)	(*f*)
Level 1	3
Level 1,5	4
Level 2	11
Level 2,5	8
Level 3	4
Level 4	1
International Physical Activity Questionnaire (*f*)	(*f*)
Sedentary	3
Insufficiently active	15
Active	9
Very Active	4

Note. SD = Standard deviation; *f* = Frequency.

Table 2 presents mean and standard deviation of two elbow positions on both sides for HGS, as well as the results for t-test and clinical effect between-groups. There is no significant difference between elbow positions for HGS. The highest scores were performed by right side.

Table 2. Comparisons between elbow positions for HGS.

Side	Elbow in Extension (Mean ± SD)	Elbow in Flexion (Mean ± SD)	*p*	*d*
Right	31.48 ± 8.77	31.87 ± 9.24	0.64	-0.04
Left	28.58 ± 8.04	29.61 ± 8.63	0.07	-0.12

Note. Mean and SD are represented in kilograms-force; *p* = significance level; *d* = Cohen's test.

DISCUSSION

The main results indicate there was no significant difference between the flexed and the extended protocol for HGS, in fact the effect size is negative and very small, which shows that there is no clinical effect. Results shows higher values in the HGS for the right hand, as has been shown by other studies[9,11,15,22,23].

The fact that there was no difference in muscle strength between the two elbow conditions is in accordance with other studies that compared elbow positions for HGS and found no significant difference between elbow in full extension or flexed at 90º in different populations[9,15,22,24,25]. However, it is important to note that, although not statistically significant, strength differed by 0.165 kg[9], 0.5 kg[15], 19 kg[22], 0.8 kg[24] and 0.13 kg[25] in these 5 studies. In accordance with the studies mentioned above, the 2 values do not differ more than 1.42 kg, showing that difference between elbow positions for HGS is irrelevant for

people with PD. A person with PD may not be able to contract all muscles for a determined task, this can be a consequence of a reduction in dopamine signals sent from the substantia nigra to the striatum. Thus, the result is excessive activity in basal ganglia's output activity which reduces activation of the motor cortex for any movement[26].

Desrosiers et al.[11] compared the same two protocols used in this study, with healthy elderly people who were right-handed, and found a significant difference for HGS only in the left hand, where elbow flexed was higher by 0.88 KgF. Aging process causes a faster degeneration on the non-dominant side of the subjects by dissociation of motor cortices, characterized, at least, by a decline of the non-dominant hemisphere[27], probably this can explain why Desrosiers et al.[11] found different results for each hand and for our study.

PD neurodegeneration negatively affects dopamine production, that is responsible for the preparation, initiation, and execution of movement. So, the depletion of dopamine can result in changes neuronal activity[28], which in turn may alter movements and motor control generated by neural circuits of the brain and the spinal cord[29]. In other words, PD neurodegeneration affects strength[5] and muscular contraction[26], Su et al.[14] and Oxford[16] found that the extended elbow position is significantly higher than the flexed for HGS, regardless of age and gender in healthy individuals. Besides that, in Su et al.[14] study the same age group have twice strength when compare with our volunteers in elbow flexed at 90º. Kuzala and Vargo[17] also found that the HGS for extended elbow position is significantly higher than the flexed. But, in their study there were more women than men, almost double, ranging in age from 21 to 46 years, already Mathiowetz et al.[23] found that the flexed elbow position is significantly higher than the extended for HGS in healthy young women.

The study has some limitations, first a small sample size, which may be affected the statistical analyses. Second, not perform a retest, which could give more strength to statistical analyses, due the small sample size, Third, the non-randomization of the elbow position, as well as the arms order. Fourth, the individual's dexterity and the most affected side by the disease were not collected. Fifth, the patient's medications were not collected. Sixth, the disease diagnosis time were not collected. For further investigations it is suggested fill the gaps of our work limitations.

For practical application, our results showed performing the handgrip test on people with PD with their elbows flexed or extended will produce the same results. For clinical practice, if the patient feels uncomfortable when flexing the elbow, the HGS test can be performed with the elbow extended. Also, HGS has been considered an important predictor of full-body muscle strength and functional capacity, that is, in both cases, the HGS is an important measure.

CONCLUSION

Our findings suggest that there is no difference between elbow positions for HGS in people with PD. It is also clear that previously reported studies do not report consistent results since some studies show no difference is strength as a function of elbow position, some show a benefit for flexion and others extension. Therefore, the ASHT standardized position is recommended for testing of HGS.

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Compliance with ethical standards

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – University of Brasilia and the protocol was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: SC. Performed the experiments: SC, EB, RV. Analyzed the data: SC, JC. Contributed reagents/materials/analysis tools: SC, LB. Wrote the paper: SC, EB, RV, JC, LB.

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