

Production capacity of maximal isometric grip strength in women with rheumatoid arthritis: a pilot study

Capacidade de produção de força de preensão isométrica máxima em mulheres com artrite reumatoide: um estudo piloto

Capacidad de producción de fuerza de presión isométrica máxima en mujeres con artritis reumatoide: una investigación experimental

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ABSTRACT | The aim of this study was to verify the capacity of maximum handgrip strength (HGS_{max}) in women with rheumatoid arthritis (RA) and its relationship with disease activity. Nine women with RA and ten healthy women were selected. The demographics data were recorded of both groups, and clinical characteristics of women with RA. The level of disease activity was evaluated by the protocol Disease Activity Score (DAS-28) using C-Reactive Protein (CRP). To measure the HGS_{max} was used an extensometer dynamometer. The results showed a statistically significant difference of HGS_{max} between the participants (Arthritis and Control: 129.41 ± 52.10 e 192.46 ± 38.98 N). In relation to dominance, women with RA showed no significant difference in HGS_{max} . The results of HGS_{max} for the dominant hand showed a strong linear relationship with the CRP ($r=0.751$). It also noted that was a moderate non-linear relation of HGS_{max} for the dominant hand and non-dominant with the number of tender and swollen joints. Thus, it is clear that women with RA have reduced ability to produce HGS_{max} independent of dominance, in addition, this study demonstrated the direct relationship that exists between HGS_{max} and the level of disease activity.

Keywords | Arthritis Rheumatoid; Muscle Strength Dynamometer, C-Reactive Protein.

RESUMO | O objetivo deste estudo foi verificar a capacidade de produção de força de preensão manual máxima (FPM_{max}) em mulheres com artrite reumatoide (AR) e sua relação com a atividade da doença. Foram selecionadas nove mulheres com AR e dez mulheres saudáveis. Foram registrados dados demográficos de ambos os grupos, além de características clínicas das mulheres com AR. A determinação do nível da atividade da doença foi conduzida pelo protocolo *Disease Activity Score* (DAS-28) por meio da Proteína C-Reativa (PCR). Para aquisição da FPM_{max} foi utilizado o dinamômetro do tipo extensômetro. Os resultados demonstraram diferença significativa da FPM_{max} entre as participantes (Artrite e Controle: $129,41 \pm 52,10$ e $192,46 \pm 38,98$ N). Em relação à dominância, as mulheres com AR não apresentaram diferença significativa na FPM_{max} . Os resultados obtidos da FPM_{max} para a mão dominante evidenciaram uma forte relação linear com a PCR ($r=0,751$). Também se constatou uma moderada relação não linear da FPM_{max} para a mão dominante e não-dominante com o número de articulações dolorosas e edemaciadas. Assim, fica evidente que mulheres com AR apresentam redução na capacidade de produzir a FPM_{max} independente da dominância, além do que este estudo demonstrou a relação direta que existe entre a FPM_{max} e o nível de atividade da doença.

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Descritores | Artrite Reumatoide; Dinamómetro de Fuerza Muscular; Proteína C-Reactiva.

RESUMEN | Este artículo tuvo como objetivo verificar la capacidad de producción de fuerza de prensión manual máxima (FPM_{max}) en mujeres con artritis reumatoide (AR) y su relación con la actividad de la enfermedad. Han sido elegidas nueve mujeres con AR y diez saludables. Se han registrado datos demográficos de los dos grupos, además de las características clínicas de las mujeres con AR. La determinación del nivel de actividad de la enfermedad se realizó por el protocolo *Disease Activity Score* (DAS-28) a través de la Proteína C-Reactiva (PCR). Para la adquisición de la FPM_{max} se utilizó el dinamómetro de tipo extensómetro. Los resultados muestran una diferencia significativa de

la FPM_{max} entre los participantes (Artritis y Control: 129,41±52,10 e 192,46±38,98 N). Con respecto a la dominación, las mujeres con AR no presentaron diferencias significativas en la FPM_{max}. Se obtuvo resultados para la mano dominante en el cual mostró una fuerte relación lineal con la PCR ($r=0,751$). También se comprobó una moderada relación no lineal de la FPM_{max} para la mano dominante y la no dominante con el número de articulaciones dolorosas e inflamadas. De esta manera, resulta evidente que las mujeres con AR presentan reducción en la capacidad de producción de la FPM_{max} independiente de la dominancia, además de mostrar a través de esta investigación la relación directa entre la FPM_{max} y el nivel de actividad de la enfermedad.

Palabras clave | Artritis Reumatoide; Dinamómetro de Fuerza Muscular; Proteína C-Reactiva.

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic inflammatory disease, associated with functional disabilities resulting from articular lesions^{1,2}, which mainly affects joints in the hands^{3,4}.

A method commonly used in order to assess functionality in patients with RA is the hand grip strength test (HGST)⁵, which is an effective marker for establishing the level of dysfunction in RA sufferers^{6,7}. This test provides a quantitative assessment in terms of functionality, which is pertinent because a person's ability to exert pressure with their hands plays an important role in exploring and manipulating objects, as well as contributing to everyday functions related to the upper limbs and torso^{8,9}.

The HGST has several purposes within the clinical sphere, with it being recommended to provide assistance in the diagnosis, evaluation and comparison of surgical techniques, as well as for recording purposes during the rehabilitation process and in treatment response^{10,11}.

Despite some studies having already verified the reduction of hand grip strength (HGS)^{12,13}, the mechanism that causes this functional loss remains largely misunderstood¹⁴. The functional restrictions that occur in RA can be related to the progressive and systemic characteristic of the disease, mainly to the effect of the inflammatory process that leads to joint lesions¹⁵. Some studies have verified the relationship between HGS and the level of disease activity by means of the DAS-28^{16,17}. In this sense, assessing the level of disease activity

provides objective evidence regarding the inflammatory process¹⁸, thereby contributing to understanding concerning the influence of the inflammatory process in reducing HGS in individuals with RA.

Given the aforementioned points, the aim of this study was to test the production capacity for maximum hand grip strength (HGS_{max}) in female RA sufferers and its relationship with the disease's activity.

METHODOLOGY

Study participants

Nine women with RA (arthritis group=AG) and ten healthy women (control group=CG) were selected and paired according to age (± 2 years). The AG was referred by rheumatologists, in accordance with classification criteria from the American College of Rheumatology¹⁹, with all being active arthritis sufferers (DAS-28 ≥ 2.6)²⁰. All participants with other immune disorders, cognitive deficiencies, sensory or physical of the upper limbs, blindness, estrogen, antibiotic or anticonvulsant users, active smokers and pregnant women were excluded from the study.

Clinical examinations

All participants completed a standardized form in order to record demographic data from both groups,

in addition to the clinical characteristics of the women with RA.

The level of disease activity was determined by means of the Disease Activity Score (DAS-28) Protocol, where the number of painful joints (NPJ) and number of swollen joints (NSJ) (shoulders, elbows, wrists, metacarpophalangeals, proximal interphalangeal joints and knees) are bilaterally counted. The patient's own perception regarding their state of health (SOH) was also verified, this was done using a unidimensional scale with a 0-100mm mark²¹. Together with the aforementioned parameters, the serum level of the C-reactive protein (CRP) was used in order to perform the final DAS-28²² calculation. The final score from the DAS-28 ranged from 0 to 10²³, where the higher the value, the greater the level of disease activity.

The CRP serum concentration was determined by a turbidimetric method, using a CRP-turbidátex kit (Biotécnica) and a Spectrophotometer (BTLyzer 100[®]), at a 540nm wavelength. The values were expressed in mg/L, with values up to 6mg/L being considered as normal.

In order to determine the dominant hand, the Edinburgh Handedness Inventory^{24,25} was used.

In order to find the HGS_{max}, an extensometer-type dynamometer was used. The dynamometer component responsible for measuring strength was an S-beam load cell with four strain gauges (Kyowa, Japan). The dynamometer had a load limit of 1000N (Newtons) and an excellent linearity coefficient ($r^2=0.9999$)²⁶.

Procedure for collecting the HGS_{max}

Firstly, hand size was measured in order to individually calculate the dynamometer grip, in accordance with that as described by Ruiz-Ruiz²⁷. The guidelines from the American Society of Hand Therapists²⁸ were adopted for the tests. The test's beginning and end were determined through visual feedback, where the participants observed a "press" command on their computer screens and performed a voluntary muscle contraction for a maximum of 10 seconds, in accordance with the Protocol set out by Ronningen and Kjejen²⁹. Three repetitions were alternately performed by each hand, beginning with the dominant hand²⁸. The time interval between the repetitions was 1 minute, based on the protocol from Ikemoto, et al³⁰.

HGS_{max} data processing

The data were processed through a specific routine, programmed in Scilab v.4.1.2 Software (INRIA, ENPS, France), which provided the mean from the three maximum strength curves³¹. The HGS_{max} was defined as the highest value from the strength curve vs time³². The obtained signals were recorded on a hard drive and filtered using a first order low-pass filter with a 25Hz cutoff frequency.

Statistical analysis

AG characterization was achieved through descriptive statistics, using relative frequency distributions for the categorical variables and mean and standard deviation for the continuous variables.

In order to determine the difference of HGS_{max} between AG and CG, an independent *t*-test was performed. A paired Student's *t*-test was conducted in order to identify the differences in the groups depending on dominance. Finally, a Pearson correlation test was performed between the HGS_{max} vs DAS-28, SOH and CRP. The relationship between the HGS_{max}, NPJ and NSJ was verified by means of the Spearman test.

The analyses were done using the Statistical Package for the Social Sciences (SPSS-20.0 Version) software, while adopting a 5% significance level.

RESULTS

19 women were evaluated, with an average age of 56.31 years, 9 of these being from the AG, 10 from the CG. Among the clinical characteristics from the AG, all the participants who were found to have active arthritis presented a positive rheumatoid factor with pain being the complaint most made (Table 1).

Table 1. Clinical characteristics of the AG participants (n=9)

Variables	Mean±SD or frequency (%)
Age (years)	56.66±11.81
Diagnosis (years)	9.77±6.70
Main complaint	
Pain	88.90
Joint stiffness	11.10
DAS-28	5.04±1.00
CRP (mg/L)	3.78±3.11
Rheumatoid Factor	
Positive	77.80
Negative	22.20

While assessing the HGS_{max}, a statistically significant difference was observed between the AG and CG in both hands. The HGS_{max} from the AG was 129.41±52.10N, whereas that from the CG was 192.46±38.98N (Chart 1). Regarding dominance, women from the AG did not show any significant difference in the HGS_{max}. However, there was a significant difference found in the CG for the HGS_{max}, as regards to dominance (Chart 1).

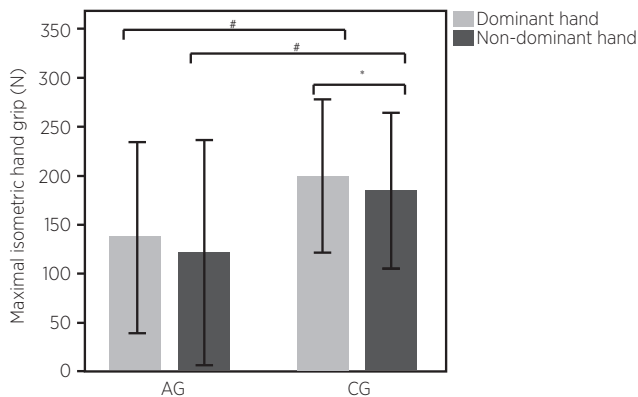


Chart 1. Maximal isometric hand grip strength of the dominant and non-dominant hand from the AG and CG.
Signifies p<0.05 in the comparison between the AG and the CG. Independent Student's t-test.
* Signifies p<0.05 in the comparison between the dominant and non-dominant hand in the CG. Paired Student's t-test

Based on the correlation tests, in both hands, the HGS_{max} showed no linear relationship with the total score from the DAS-28. However, the results from the HGS_{max} for the dominant hand showed a moderately linear relationship with SOH and a strong linear relationship with CRP. Whereas, for the non-dominant hand, there was a strong linear relationship between the HGS_{max} and the SOH, while there was no significant linear relationship with CRP. A moderate non-linear relationship of the HGS_{max} was found for the dominant and non-dominant hand with NPJ and NSJ (Table 2).

DISCUSSION

The HGS_{max} results from the tests corroborate with those from published data, thereby reiterating the

finding that women with RA have lesser HGS_{max} when compared with healthy women³³⁻³⁶.

Concerning the difference in the HGS_{max} in relation to dominance, data from the literature are controversial. Fraser, et al.³⁷ found that the dominant hand of patients with RA was on average 20% weaker than the contralateral hand. Whereas, in healthy individuals, the dominant hand was stronger than the non-dominant hand. Another study³⁸ found that the dominant hand of individuals with RA presented greater HGS_{max}. Due to these contradictory findings, it is difficult to draw conclusions regarding the influence of dominance on grip strength³⁹.

In the assessment of the relationship of HGS_{max} with the disease activity parameter, the HGS_{max} has been described to present a good association with this variable⁴⁰. In this sense, Dedeoglu, et al.⁴¹ found a negative correlation between HGS_{max} and DAS-28. This relationship was strengthened by West and Wallberg-Jonsson⁴², during a longitudinal study in which a negative relationship was observed between HGS_{max} with DAS-28 and CRP. Arvidson, et al.^{43,44} also demonstrated a negative association between CRP and HGS_{max}. Despite no correlation having been verified between HGS and the total DAS-28 score, this study found a negative correlation with NPJ, NSJ and SOH and a positive correlation with CRP.

CRP can serve as a regulatory marker of the inflammatory pathway and other inflammatory markers⁴⁵. Disease activity plays an important role in the mechanism that contributes to physical and functional impairment in patients with RA⁴⁶. The association between the disease activity parameters and the HGS_{max} suggests that the inflammatory process can act as catabolic mediators in the muscle⁴⁷.

Häkkinen, et al.⁴⁸ believed that the reduction in strength is related to the inflammatory process, which consequently leads to the affected limb becoming disused, and thereby resulting in functional and structural changes linked to the neuromuscular system, such as the reduction of voluntary neural activation and muscle atrophy. Inflammation is one of the first signs that are

Table 2. Relationship between the HGSmax of the dominant and non-dominant hand with the parameters for disease activity in the AG

HGS _{max}	NAD	NAE	EGS	PCR	DAS28
Dominant	rho=-0.542* p=0.00	rho=-0.537* p=0.00	r=-0.527** p=0.01	r=0.751** p=0.01	r=0.336 p=0.18
Non-Dominant	rho=-0.528* p=0.01	rho=-0.435* p=0.03	r=-0.681** p=0.00	r=0.533 p=0.07	r=0.000 p=0.50

* Signifies p<0.05 in Spearman's Correlation (rho); ** Signifies p<0.05 in the Pearson correlation coefficient (r), (p<0.05). NPJ: number of painful joints; NSJ: number of swollen joints; SOH: state of health

related to joint destruction, ligament laxity and an imbalance in muscle function in individuals with RA. The progression of this pathological process can generate serious deformities, which results in significant functional limitations⁴⁹.

Another mechanism resulting from inflammation that contributes to the loss of motor command, to atrophy and to muscle weakness is pain⁵⁰. The process that triggers pain in RA sufferers is related to the peripheral sensitization, where the afferent nerves become hypersensitive to movement^{51,52}. Considering that pain was the main complaint clinic mentioned by patients, as was verified negative correlation between HGS_{max} and NPJ, the data from this study reinforce the involvement of the inflammatory process in the reduced HGS_{max} of individuals with RA.

However, it is important to stress that given the small number of individuals evaluated, where the participants were selected by convenience, as well as the absence of radiological examination in order to determine the state of the disease, there is a limitation inherent to this study, thereby damaging the generalization of the obtained results. Such limitations occurred due to the difficulty of finding patients with RA who were available to go to the laboratory to participate in the study, as well as the lack of funding to perform radiological examinations. Despite their preliminary nature, the data from this study is considered relevant for characterizing the HGS of patients with RA, participants of studies developed in our laboratory. Finally, it is clear that further work must be performed with a larger number of subjects in order to study and characterize the relationship between HGS and the level of disease activity. The information from this study will contribute in terms of improving the quality of life for these individuals; it also highlighted the importance and relevance of the multidisciplinary treatment, and thereby should lead to better management and treatment of the pathology.

CONCLUSION

The findings showed that women with RA presented a reduction in their ability to produce HGS_{max}, regardless of the dominant hand. In addition, they demonstrated that there is a direct relationship between HGS_{max} and the determining parameters for the level of disease activity.

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