

FUNCTIONAL EVALUATION OF HANDS IN PEOPLE WITH AND WITHOUT ARTHROPATHY OF JACCOUD ASSOCIATED WITH LÚPUS

AVALIAÇÃO FUNCIONAL DA MÃO EM PESSOAS COM E SEM ARTROPATIA DE JACCOUD ASSOCIADA AO LÚPUS

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RESUMO | **Introdução:** O lúpus eritematoso sistêmico (LES) é uma doença autoimune, crônica, de caráter difuso, que causa, dentre outros fatores, comprometimento articular. A Artropatia de Jaccoud (AJ) é uma inflamação deformante e reversível, que ocorre nas articulações proximais, mais frequentemente observadas em membros superiores. A prevalência epidemiológica da AJ é de 5% para pacientes com LES. O mau alinhamento ou a perda de força podem limitar o movimento, gerar compensações e sobrecargas articulares. O diagnóstico funcional precoce pode auxiliar a reduzir a instalação das deformidades articulares. **Objetivo:** Comparar a amplitude de movimento e a força de preensão palmar em pessoas com e sem AJ associado LES. **Métodos:** Estudo transversal onde os pacientes foram alocados em dois grupos: com diagnóstico de LES e com diagnóstico de LES associado à AJ. Os instrumentos utilizados: dinamômetro, goniômetro de dedos e o goniômetro universal. **Resultados:** Participaram do estudo 67 mulheres com LES, das quais, 32 tinham AJ. As características sociodemográficas e clínicas dos grupos foram consideradas homogêneas para as variáveis analisadas. Foi observada uma diferença significativa entre os grupos, com exceção do grau de extensão da interfalangeana do primeiro quirodáctilo direito ($p=0,073$), da interfalangeana distal do quarto quirodáctilo esquerdo ($p=0,083$) e interfalangeana distal do primeiro quirodáctilo esquerdo ($p=0,435$). **Conclusão:** As pessoas com AJ associada ao LES apresentaram amplitude articular superiores e força de preensão palmar menor em relação às pessoas apenas com LES. Estes resultados sugerem que ainda há necessidade de estudos complementares para observação da funcionalidade de mãos destas pessoas.

Palavras-Chaves: Lúpus Erimatomatoso Sistêmico. Artropatia de Jaccoud. Força muscular. Goniometria. Deformidade em Mãos

ABSTRACT | **Introduction:** Systemic lupus erythematosus (SLE) is a chronic autoimmune disease of a diffuse nature, which causes, among other factors, joint involvement Jaccoud arthropathy (AJ) is a reversible deforming inflammation that occurs in the proximal joints, Frequently seen in upper limbs. The epidemiological prevalence of AJ is 5% for SLE patients. Poor alignment or loss of strength can limit movement, generate compensations and joint overloads. Early functional diagnosis may help reduce the installation of joint deformities. **Objective:** To compare the range of motion and palmar grip strength in people with and without AJ associated with SLE. **Methods:** A cross-sectional study where patients were allocated to two groups: diagnosed with SLE and diagnosed with SLE associated with AJ. The instruments used: dynamometer, finger goniometer and the universal goniometer. **Results:** 67 women with SLE participated in the study, of which 32 had AJ. The sociodemographic and clinical characteristics of the groups were considered homogeneous for the analyzed variables. A significant difference was observed between groups, except for the extent of interphalangeal extension of the first right mandibular ($p=0.073$), distal interphalangeal of the fourth left ($p=0.083$) and distal interphalangeal of the first left mandibular ($p=0.435$). **Conclusion:** People with AJ associated with SLE had higher joint amplitude and lower palmar grip strength compared to those with SLE alone. These results suggest that there is still a need for complementary studies to observe the functionality of these people's hands.

Key-Words: Systemic Lupus Erythematosus. Jaccoud Arthropathy. Muscular Strength. Goniometry. Deformity in hands

INTRODUCTION

Systemic lupus erythematosus (SLE) is an autoimmune, diffuse and chronic disease that causes joint involvement^{1,2,3}. The most common signs and symptoms are joint pain, stiffness, non-erosive arthritis (Jaccoud arthropathy) or erosive (rhupus)⁴. Until an accurate analysis of the health condition is obtained, the individual may receive different diagnostic hypotheses, which often implies late treatment⁵. Jaccoud arthropathy (AJ) is a clinical manifestation that was primarily described in association with rheumatic fever, and been observed in connective tissue diseases, as SLE^{6,7,8}, dermatomyositis⁹, Intestinal inflammations, psoriatic arthritis, among others^{5,10,11}.

AJ is a non-erosive, reversible deforming inflammation that occurs in proximal joints, most often seen in upper limbs⁶⁻⁸. Commonly affects metacarpophalangeal (MF) and interphalangeal (IF) joints⁵. Epidemiological prevalence of AJ is 5% for patients with SLE^{10,11}. AJ is a rare disorder, and there are some case reports with epidemiological and clinical data⁵. Imaging tests of the hand with AJ can be found three types of deformities¹. Musculoskeletal manifestations characteristic of AJ are: swan neck, ulnar deviation, thumb subluxation and hallux valgus⁶⁻⁸.

Joint deformities generated by degenerative diseases lead to incapacities and functional dependencies, and thus generate economic costs for both the patient and society¹². Therapeutic strategies must be preceded by a preliminary and detailed evaluation¹³. Few radiological and clinical studies in AJ^{4,5} delineated the functional profile in this health condition, as recommended by the World Health Organization through the International Classification of Functioning, Disability and Health (ICF).

Measurement of manual grip strength and joint amplitude, which may contribute to the elaboration of more precise protocols for functional characteristics, which may contribute to the elaboration of evaluation protocols for monitoring clinical evolution and for responses therapeutic procedures. Lack of alignment or loss of strength can limit movement, generate compensations and joint overloads. Early functional diagnosis may help reduce the installation of disabling articular deformities for manual activities. This study aims to compare the range of motion and

palmar grip strength in people with and without JA associated with SLE.

MATERIALS AND METHODS

Cross-sectional study. Fulfilled in outpatient clinics of Bahiana School of Medicine and Public Health (ADAB), situated in Brotas, Salvador, Bahia. Data collection occurred from September to December of 2014. ADAB comprises two units in Brotas and Cabula, providing private and public services, in addition to having an association with the Salvador Municipal Health Department and Unified Health System.

Inclusion criteria's were selected people who were in regular follow-up in SLE outpatient clinic, met classification criteria's of SLE proposed by American College of Rheumatology² and JA according criteria's proposed by Santiago¹⁴ who were on medication in use stabilized for at least six consecutive months. Exclusion criteria's were pregnant patients; with poor understanding of the underlying disease or evaluation tools and patients with rhupus.

Predictor variables were age, time of disease, occupation and dominance; The occupation was divided into light: retired, unemployed, clerk, beneficiary, disability; moderate: community agent; High: student, housewife, administrator, laundress, artisan, secretary, drawer, farmer and teacher. Outcome's variables was joint amplitude and palmar grip strength. Data were from a primary source, collected in a previously reserved room where the physical evaluation.

Individuals were allocated into two groups: those diagnosed with SLE and those diagnosed with SLE associated with JA. To reduce the risks of bias, the interviews and the structuring of the database were done by an independent examiner. Instruments used were: manual hydraulic dynamometer JAMAR®; finger goniometer Inches® and universal goniometer Carci®.

Before measurement of palmar grip strength, an evaluation of the range of joint motion, by same examiner, and patients were placed in a blood collection chair, so that there was minimal musculoskeletal compensation during data collection. Articular amplitudes evaluated were ulnar deviation of the wrist, with goniometer fulcrum located in middle of the dorsal face of wrist, in radio's lister tuber. Fixed arm alignment was the forearm and movable arm was third metacarpal's dorsal midline¹⁵. Fingers ulnar deviation was also evaluated, where fulcrum of movement was located in hands extensor musculature's tendon, in third metacarpus's head region.

Joint examination's second part consisted on measurement of bilateral fingers. Inches finger goniometer was used, the extent of proximal IF joints was measured and distal regions of II, III, IV and V fingers. Forearm at 0° of supination and pronation. Flexion, extension, radial and ulnar deviations of the wrist at 0°. Flexion, extension, abduction and adduction of 0° MF joint. Movement fulcrum was situated in the center of each joint, fixed arm, aligned with proximal and medial phalanx, respectively, and movable arm followed median phalanx and distal phalanx of each finger evaluated¹⁶.

Then, IF joint of 1st finger was evaluated. Forearm in total supination, wrist with ulnar and radial deviation, flexion and extension at 0 degrees. Carpometacarpal joint in 0° of flexion, extension, abduction, adduction and opposition. MF joint in 0° of flexion and extension¹⁷.

For security measure, and to ensure statistical reliability, the complementary angles for extension were described, since negative signal, commonly designated to describe extension, was not used. This influenced measures normally used as standard joints references.

Measurement of muscle strength was performed by American Society of Hand Therapists (SATM) and American Society of Hand Surgery (SACM) positions recommended. Jamar brand analog hydraulic dynamometer was considered a validated, reliable and gold standard instrument in the literature²⁰.

A room without noise and ambient light was reserved previously. Before starting, was demonstrated

through a simulation how evaluation would be and any doubts were taken¹⁵.

During assessment no verbal commands were given nor mentioned. Patients sat in a plastic chair without arms where and angle of hips and knees were approximately 90°, and feet supported on floor. Was certified if feet were supported the ground when compared to height of seat, for those who did not lean was placed books, according to patient height. Patients were instructed to make a shoulder adduction, a 90° elbow flexion, forearms in a neutral position. It is recommended wrist extension of 0°-30° and adduction of 0°-15° to evaluated upper limb. When was ready, the subject had tightened dynamometer with maximum isometric effort, which is held for about three seconds, three consecutive times with a thirty-second interval between each hold. Started with right hand and then, left hand^{15,18,19}.

Patients were corrected for placements if there was a need and were instructed to remove objects that could influence the evaluation such as watches, rings, bracelets. Was performed three times and remained the highest value.

Collected data were inserted in software IBM Statistical Package for Social Sciences (SPSS v.21). Stored on a computer in a confidential way with a password, so that there was no change of data. For the calculation of the sample, which estimated that 68 individuals were required, a standard deviation of 5 and difference to be detected of 3Kg / f measurements dynamometer between groups with and without JA, level of significance of 5%, a power of study of 80%, using the laboratory calculator of epidemiology and statistics of USP (available in: www.lee.dante.br/cgi-bin/uncgi/calculo_amostral)²⁰.

Data were descriptively evaluated through mean, deviation, median, minimum and maximum, in continuous variables, and through of frequencies and percentages for categorical variables. To verify the homogeneity of the groups in relation to variables such as age, time of diagnosis of the disease, occupation, dominance, Student's t-tests were performed for comparison of mean between groups; Mann Whitney test was used for non-parametric comparison of selected numerical variables: Palmar grip strength, ulnar deviation,

finger deviation, proximal interphalangeal (IFP) and distal interphalangeal (IFD). Each group was trend check in diagnosis time for comparison, according to the normality in the data.

This study is part of a doctoral project entitled: Effect of an exercise protocol on hands function in patients with Jaccoud's Arthropathy associated with Systemic Lupus Erythematosus: pre and post pilot study, submitted and approved by the CEP

of the Catholic University of Salvador, CAAE: 63008116.6.0000.5628, in accordance with 466/12 resolution. Participant's cultural, social, moral, religious and ethical values have always been preserved and the procedure provided will ensure reliability and privacy. Materials and data collected in research had sole purpose foreseen and informed in Informed Consent Form (ICF). This study only started after the participant signed ICF, allowing their research participation.

RESULTS

Participated 67 women with SLE, of which 32 had JA. Sociodemographic and clinical characteristics are presented in Table 1. Groups were considered homogeneous for the analyzed variables.

Table 1. Sample characterization of patients with systemic lupus erythematosus from a reference outpatient clinic in Salvador, Bahia, Brazil, 2014.

Variable	SLE with JA	SLE without JA	p-value
	Mean ± SD	Mean ± SD	
	n/%	n/%	
	n=32	n=35	
Age	46,13 ± 11,28	45,89 ± 10,05	0,927
Disease diagnosis	15,00 ± 7,91	13,81 ± 6,14	0,079
Dominance			0,609
right-handed	31 (48,44%)	33 (51,56%)	
left-handed	1 (3,33%)	2 (6,67%)	
Current Occupation			0,388
Lightweight Manual Activity	13 (40,63%)	13 (37,14%)	
Moderate Manual Activity	0 (0,00%)	2 (5,72%)	
High Activity Manual	19 (59,37%)	20 (57,14%)	

T test for comparison between groups; Fisher's exact test for proportions between groups.

When comparing groups in relation to numerical variables analyzed, a significant difference was observed between groups in all parameters, with exception of degree of extension of distal right first IF ($p= 0,073$), left fourth distal IF ($p= 0,083$) and degree of extension of distal left first IF ($p= 0,435$), according Table 2.

Table 2. Characteristics of grip strength and hand angulation in patients with Systemic Lupus Erythematosus with and without Jaccoud Arthropathy in an outpatient clinic in Salvador, Bahia, Brazil, 2014.

Variable	SLE with JA	SLE without JA	p-value
	Median (Q1-Q3)	Median (Q1-Q3)	
RH strength	14,00 (7,25 -19,50)	22,60 (17,00 – 26,50)	0,001
LH strength	10,75 (9,12 -17,75)	19,00 (16,00 – 27,00)	0,001
RW ulnar deviation	10,00 (5,50 - 18,50)	0,00 (0,00 – 10,00)	0,004
RF ulnar deviation	10,00 (6,50-20,00)	0,00 (0,00 – 10,00)	0,001
LW ulnar deviation	10,00 (0,00-10,00)	0,00 (0,00 – 10,00)	0,029
LF ulnar deviation	10,00 (0,00-18,50)	0,00 (00,00 – 00,00)	0,001
R IFP 5 th	190,00 (182,50 – 200,00)	180,00 (180,00 – 180,00)	0,001
R IFD 5 th	175,00 (160,00 - 180,00)	180,00 (180,00 – 180,00)	0,005
R IFP 4 th	200,00 (190,00 – 204,50)	180,00 (180,00 – 180,00)	0,001
R IFD 4 th	180,00 (170,00 – 190,00)	180,00 (180,00 – 190,00)	0,029

Table 2. Characteristics of grip strength and hand angulation in patients with Systemic Lupus Erythematosus with and without Jaccoud Arthropathy in an outpatient clinic in Salvador, Bahia, Brazil, 2014.

(continuação)

Variable	SLE with JA	SLE without JA	p-value
	Median (Q1-Q3)	Median (Q1-Q3)	
R IFP 3 rd	199,00 (190,00 – 210,00)	180,00 (180,00 – 190,00)	0,001
R IFD 3 rd	175,00 (170,00- 180,00)	180,00 (180,00 – 190,00)	0,001
R IFP 2 nd	190,00 (180,00 – 203,00)	180,00 (180,00 – 180,00)	0,001
R IFD 2 nd	170,00 (170,00 - 180,00)	180,00 (180,00 – 180,00)	0,001
R IFD 1 st	200,00 (182,50 – 210,00)	196,00 (180,00 – 200,00)	0,073
L IFP 5 th	200,00 (200,00 – 210,00)	180,00 (180,00 – 190,00)	0,001
L IFD 5 th	170,00 (160,00 - 180,00)	180,00 (180,00 – 180,00)	0,003
L IFP 4 th	200,00 (190,00 - 204,00)	180,00 (180,00 – 190,00)	0,001
L IFD 4 th	180,00 (165,5 – 119,00)	180,00 (180,00 – 190,00)	0,083
L IFP 3 rd	200,00 (190,00 – 210,00)	180,00 (180,00 – 180,00)	0,001
L IFD 3 rd	180,00 (170,00 - 180,00)	180,00 (180,00 - 190,00)	0,004
L IFP 2 nd	200,00 (190,00 - 208,50)	180,00 (180,00 – 180,00)	0,001
L IFD 2 nd	170,00 (160,00 - 170,00)	180,00 (180,00 – 180,00)	0,001
L IFD 1 st	200,00 (180,00 - 220,00)	194,00 (180,00 – 210,00)	0,435

Mann Whitney test for non-parametric comparison of selected numerical variables; Q1 = Quartil 25%; Q3 = Quartil 75%; RH - Right hand; LH - Left hand; RW - Right wrist; R - Right; LW - Left wrist ; L - Left; RF - Right finger; LF - Left finger; IFP - Proximal interphalangeal joint; IFD - Distal interphalangeal joint

DISCUSSION

Patients with JA associated with SLE present reduction of grip strength and joint hypermobility when compared with individuals without JA. All joints evaluated in the JA group showed significant hypermobility, except joints left fourth distal IF and distal first IF bilaterally. They presented similarly significant hypermobility in the non-JA group. Regarding strength, non-JA group presented approximately twice the strength of the JA group.

Palmar grip is an essential movement for the manual functions, indispensable for the accomplishment of Daily Life Activities (ADL's) and labor. Decreased performance for ADL's has been observed in people with JA¹⁴. There remain gaps in extent to which this health condition reduces functional capacity for work. No differences were observed between groups for occupation and time of disease in this study. Likewise, the time of diagnosis seems not to be decisive in the evolution of the functional. Several factors can influence palmar grip strength such as: body posture, shoulder position, elbow, wrist, hand and fingers²¹.

An ulnar deviation of wrists and fingers was

identified in the JA group. Probably due to reduction of palmar grip strength and, as compensation, grip muscles participating^{10,16} in adduction, flexion and ulnar deviation of the wrist and fingers^{5,10}. Another justification may be for people with JA have distended joint capsules and extensor tendons shortened to metacarpals ulnar side, with consequent ulnar deviation⁵. The deformity begins to settle in the second and third fingers and other fingers are being pushed towards the same direction¹⁴. Functional impacts are observed between 0° and 15° of ulnar deviations²².

People with JA have hypermobile joints⁵, as confirmed in present study. Literature has not been elucidated whether hypermobility is a result of soft tissue laxity or is a primary process of this health condition⁵. May be fibrin and fibrous thickening of joint capsules of a person with JA²³. It has been found that there is deviation in joints left fourth distal IF and distal first IF bilaterally in patients with SLE, even in the absence of JA. Patients diagnosed with SLE have hypermobile joints when compared to healthy individuals²⁴. Believed that genesis of this kinetic-functional pattern is residual fibrosis with

consequent alteration in joint capsule⁵.

Thumb is considered important in hand performance. Accounting for about 60% of palmar grasping and grip movements³. Because it presents looser ligaments and tends to a previous wear²⁵. Patients with JA are favorable for ulnar deviation of wrist, thumb's movements are functionally compromised, which may be related to the frequent subluxation^{3,5}. IF joint of the thumb is identical to that of other fingers in relation to structure and function, and may present the same degree of joint complexity¹⁷.

Fourth finger has a smaller role in hand functionality, compared to other fingers. Its loss would imply in only 10% in function¹⁶. Noteworthy that left fourth distal IF was the only joint that did not present a significant difference between people with and without JA. A probability for this finding that chance has outcome influenced.

This study has advantages of being innovative, besides being able to contribute to early treatment, before functional changes installation, in order to delay their appearance. It was inexpensive, quick and easy to perform. However, the absence of a segment does not allow establishing causal relationships between the variables.

CONCLUSION

People with AJ associated with SLE had higher articular amplitude and lower palmar grip strength compared to those with SLE. These results suggest that there is still a need for complementary studies to observe functionality of these people's hands. Randomized clinical trials should be performed in order to establish protocols and treatments for these disorders.

AUTHOR CONTRIBUTIONS

Souza CRJ participated in the conception, design, interpretation of the data, search and statistical analysis of the research data, interpretation of the results, statistical analysis of the research data, writing of the scientific article and referral of the scientific article. Galvão VL participated in the design, guided in all phases, data collection of the research, design, interpretation of data, search and statistical analysis of the data of the research, interpretation of the results, statistical analysis of the research data, writing of the scientific article.

COMPETING INTERESTS

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

REFERENCES

1. Piga M, Saba L, Gabba A, Congia M, Balestrieri A, Mathieu A et al. Ultrasonographic assessment of bone erosions in the different subtypes of systemic lupus erythematosus arthritis: comparison with computed tomography. *Arthritis Res Ther.* 2016;18(1):222. doi: [10.1186/s13075-016-1125-8](https://doi.org/10.1186/s13075-016-1125-8)

2. Tan EM, Cohen AS, Fries JF, Masi AT, McShane DJ, Rothfield NF et al. The 1982 revised criteria for the classification of systemic lupus erythematosus. *Arthritis Rheum.* 1982;25(11):1271–7.

3. Bayer L, Praetzel RP OR. Artrose da Base do Polegar ou Rizartrrose. Instituto da Mão. Porto Alegre; 2017. Portuguese.

4. Caznoch CJ, Esmanhotto L, Silva MB, Skare TL. Padrão de comprometimento articular em pacientes com lúpus eritematoso sistêmico e sua associação com presença de fator reumatóide e hiperelasticidade. *Rev Bras Reumatol.* 2006;46(4):261–5. doi: [10.1590/S0482-50042006000400005](https://doi.org/10.1590/S0482-50042006000400005). Portuguese.

5. Santiago MB. Jaccoud's arthropathy. *Best Pract Res Clin Rheumatol.* Elsevier. 2011;25(5):715–25. doi: [10.1016/j.berh.2011.10.018](https://doi.org/10.1016/j.berh.2011.10.018)

6. Aptekar RG, Lawless OJ, Decker JL. Deforming non-erosive arthritis of the hand in systemic lupus erythematosus. *Clin Orthop Relat Res.* 1974;(100):120–4.

7. Weissman BN, Rappoport AS, Sosman JL, Schur PH. Radiographic Findings in the Hands in Patients with Systemic Lupus Erythematosus. *Radiology.* 1978;126(2):313–7. doi: [10.1148/126.2.313](https://doi.org/10.1148/126.2.313)

8. Reilly PA, Evison G, McHugh NJ, Maddison PJ. Arthropathy of hands and feet in systemic lupus erythematosus. *J Rheumatol.* 1990;17(6):777–84.

9. Bradley JD. Jaccoud's arthropathy in adult dermatomyositis. *Clin Exp Rheumatol.* 1986;4(3):273–6.

10. Santiago MB, Galvão V. Jaccoud arthropathy in systemic lupus erythematosus: analysis of clinical characteristics and review of the literature. *Medicine (Baltimore).* 2008;87(1):37–44. doi: [10.1097/MD.0b013e3181632d18](https://doi.org/10.1097/MD.0b013e3181632d18)

11. López Longo FJ. Artropatía de Jaccoud: algo más que lúpus. *Semin la Fund Española Reumatol.* Elsevier. 2011;12(2):36–41. doi: [10.1016/j.semreu.2010.10.001](https://doi.org/10.1016/j.semreu.2010.10.001)

12. Mota LMH da, Cruz BA, Brenol CV, Pereira IA, Rezende-Fronza LS, Bertolo MB, et al. Consenso 2012 da Sociedade Brasileira de Reumatologia para o tratamento da artrite reumatoide. *Rev Bras Reumatol.* 2012;52(2):152–74. doi: [10.1590/S0482-50042012000200002](https://doi.org/10.1590/S0482-50042012000200002). Portuguese.

13. Oku EC, Castelar R, Maria P, Araújo P De. Hand functional assessment in patients with rheumatoid arthritis. *Fisioter Mov.* 2009;22(2):221–8.

14. Santiago MB. Jaccoud's arthropathy: Proper classification criteria and treatment are still needed. *Rheumatol Int.* 2013;33(11):2953–4. doi: [10.1007/s00296-012-2526-x](https://doi.org/10.1007/s00296-012-2526-x)

15. EE F. Grip strength. In: JS C, organizador. *Clinical Assessment Recommendations.* 2nd ed. Chicago: American Society of Hand Therapists; 1992. p. 41–5.

16. Magee D. Antebraço, Punho e Mão. Avaliação musculoesquelética. 4th ed. São Paulo: Manole; 2005. p. 353–421. Portuguese.

17. Bellace JV, Healy D, Besser MP, Byron T, Hohman L. Validity of the Dexter Evaluation System's Jamar dynamometer attachment for assessment of hand grip strength in a normal population. *J Hand Ther.* 2000;13(1):46–51.

18. Nascimento MF, Benassi R, Caboclo FD, Salvador ACS GL, Gonçalves LCO. Valores de referência de força de preensão manual em ambos os gêneros e diferentes grupos etários. Um estudo de revisão. *EFDdesportes.* Buenos Aires; 2010. Portuguese.

19. Stephens JL, Pratt N, Michlovitz S. The reliability and validity of the Tekdyne hand dynamometer: Part II. *J Hand Ther.* 1996;9(1):18–26.

20. Reis MM, Maria P, Arantes M. Medida da força de preensão manual – validade e confiabilidade do dinamômetro saehan. 2011;18(2):176–81:176-81. Portuguese.

21. Sande LAP, Coury HJCG. Aspectos biomecânicos e ergonômicos associados ao movimento de preensão: uma

revisão. Rev. Fisioter. Univ. São Paulo. 1998;5(2):66-148. Portuguese.

22. Pryce JC, Forward EM, Flatt AE, Stephens RI. The wrist position between neutral and ulnar deviation that facilitates the maximum power grip strength. J Biomech. 1980;13(6):505-11.

23. Girgis FL, Popple AW, Bruckner FE. Jaccoud's arthropathy: a case report and necropsy study. Annals of the Rheumatic Diseases. 1978;37:561-5.

24. Gumà M, Olivé A, Roca J, Forcada J, Duró JC, Holgado S et al. Association of systemic lupus erythematosus and hypermobility. Ann Rheum Dis. 2002;61(11):1024-1026. doi: [10.1136/ard.61.11.1024](https://doi.org/10.1136/ard.61.11.1024)

25. Silva JB, Gazzalle A, Alvarez G, Cunha GL. Lesões tendinosas da mão. Rev da AMRIGS. 2011;2(55):197-201. Portuguese.