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Review article

Evaluation protocols of hand grip strength in individuals with rheumatoid arthritis: a systematic review

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ABSTRACT

Hand grip strength is a useful measurement for individuals with rheumatoid arthritis, since this disease is often associated with functional anomalies of the hands and a consequent reduction in muscular strength. Thus, the standardization of the test protocol is important in relation to make reproducible and reliable studies. The aim of this systematic review was to verify the parameters associated with the measurement of the hand grip strength in individuals with rheumatoid arthritis. The review was carried out according to the recommendations of PRISMA, based on the databases of the Web of Science and the Journals Website of the Brazilian governmental agency CAPES. The following inclusion criteria were established: articles whose themes involved dynamometry to measure the hand grip in adult patients with rheumatoid arthritis, published in English between 1990 and 2012. The articles were selected by two independent reviewers. Initially, 628 articles were identified, and in the final review only 40 were included in the qualitative synthesis, that is, those in which the main tool used to evaluate the hand grip strength was the Jamar®. In relation to the hand grip strength parameters feedback type, hand dominance, repetitions, contraction intensity, acquisition time and rest period many data are imprecise and were not detailed in the method description. It is clear that there is a need for the standardization of a protocol which establishes the type of dynamometer and the parameters to be evaluated and also takes into consideration the clinical conditions of patients with rheumatoid arthritis.

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Protocolos de avaliação da força de preensão manual em indivíduos com artrite reumatoide: uma revisão sistemática

R E S U M O

Palavras-chave:

Artrite reumatoide
Preensão manual
Parâmetros de medida
Dinamometria

A força de preensão manual é uma medida útil nos indivíduos com artrite reumatoide, pois a doença está muitas vezes associada a anormalidades funcionais das mãos e consequente redução da força muscular. Dessa forma, a padronização do protocolo do teste é importante por tornar os estudos reprodutíveis e confiáveis. Essa revisão sistemática teve como finalidade verificar os parâmetros de medida da força de preensão manual em indivíduos com artrite reumatoide. A revisão foi realizada de acordo com as recomendações PRISMA, nas bases de dados *web of science* e no Portal de Periódicos da CAPES. Foram estabelecidos os seguintes critérios de inclusão: artigos cujos temas envolvessem a dinamometria de preensão manual em pacientes adultos com artrite reumatoide, no idioma inglês, publicados entre 1990 e 2012. Os artigos foram selecionados por dois revisores independentes. Inicialmente foram identificados 628 artigos, sendo que na revisão final apenas 40 artigos foram incluídos na síntese qualitativa; destes, verificou-se que o principal instrumento utilizado para avaliação da força de preensão manual foi o Jamar®. Em relação aos parâmetros da força de preensão manual: tipo de *feedback*, dominância, repetições, intensidade da contração, tempo de aquisição e tempo de descanso, muitos dados são imprecisos e não foram criteriosos na descrição do método. Evidencia-se a necessidade de padronização de um protocolo que estabeleça o tipo de dinamômetro, os parâmetros a serem avaliados e ainda leve em consideração as condições clínicas dos pacientes com artrite reumatoide.

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Introduction

Rheumatoid arthritis (RA) is a major challenge to clinicians, rheumatologists, physiotherapists and researchers, not only because of its increasing long-term mortality, but also by work incapacitation, and the evidence of producing joint damage, weakness, fatigue, and general functional decline.^{1,2}

In these individuals, handgrip is a useful parameter of evaluation,³ since muscle weakness is a common symptom, of disuse atrophy, which results in systemic inflammation as well as of pain and joint stiffness.⁴

In the clinical context, handgrip strength serves several purposes, it is recommended for clinical diagnosis, for the evaluation and comparison of surgical techniques, for the documentation of the progress during rehabilitation, the response to treatment and the level of disability after injury.^{5,6}

Handgrip strength can also be used as an indicator of overall strength and general health,⁷ commonly used in professional environments to evaluate the performance of athletes who depend on an adequate level of grip strength to maximize control and performance and to reduce possible injuries.⁸

Despite the handgrip being a routine measure in the evaluation of patients with RA, little attention has been paid to the importance of standardization of the test protocol for patients with this disease. The use of a standard protocol is important to improve the accuracy and consistency of the test, since differences in the protocols used can affect the reproducibility of measurements and the comparison of the absolute values to other studies.⁹

Given the importance of a standard protocol for the handgrip test in patients with RA, our study aims to conduct a sys-

tematic review to investigate the disease's treatment state-of-the-art, verifying which are the most used protocols for handgrip strength evaluation in RA patients .

Method

This systematic review was performed according to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)¹⁰ which consists of a checklist of 27 items and a flow diagram and includes items deemed essential for a clear reporting of systematic reviews.

Eligibility criteria

The review included only observational and uncontrolled studies in English, encompassing adults with RA and handgrip strength dynamometry, published between 1990 and 2012, available in complete form. Randomized clinical trials (RCTs) were not included, because in an initial search the terms associated with a sensible search list for RCTs developed by Robinson and Dickersin (2002)¹¹ did not yield any result.

The outcomes included were: type of dynamometer handgrip strength test (feedback, dominance, repetition, intensity of contraction, acquisition time, and rest time) and strength analysis. Feedback is understood as the stimulus needed to maximize the individual's performance in the handgrip strength test, which may be visual or verbal. The following exclusion criteria were adopted: juvenile arthritis and/or other rheumatic diseases, review articles, meetings' proceedings, conference summaries and duplicate records.

Search strategy

The following electronic databases were searched: Web of Science and the online periodicals portal CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), using as search strategy the following combination of terms in English: “(Grip strength maximal isometric* OR handgrip muscle strength* OR hand-grip dynamometry* OR handgrip strength* OR handgrip strength test contraction speed*)” AND “rheumatoid arthritis”.

In sequence, with the aid of database tools, a search refinement was performed using the following keywords: “rheumatoid arthritis”, “arthritis rheumatoid”, “muscle strength”, “hand”, “hand strength”, “grip strength”, “isometric contraction”, “mortality” and “grip”.

Study selection and data extraction

The first selection of articles was carried out from title reading, and the second selection was conducted from the analysis of abstracts and keywords. To manage duplicate files, we used EndNote Web (version 3.3), a management system of references. The titles and abstracts of all articles identified by the search strategy were independently assessed by two of the authors of this paper (APS and RRI).

In this second phase the reviewers independently evaluated the full papers and made their selections, according to the eligibility criteria previously specified. The outcomes were: pneumatic dynamometer, Jamar and digital dynamometer, measured in N (Newton) or kgf, in relation to the handgrip parameters; the outcomes were: type of feedback (visual or verbal), dominance (right or left), number of repetitions, intensity contraction (maximum strength), acquisition time and rest (in seconds or minutes, and the kind of strength analysis (best result or average).

Assessment of risk of bias

No method to assess the risk of bias in included studies was used for studies of different design.

Results

A total of 628 articles were identified by the reviewers, and 420 were obtained from the CAPES website (SciVerse, ScienceDirect, MEDLINE, Science Citation Index Expanded, OneFile, SpringerLink, Oxford Journals, Social Sciences Citation Index, Future Science Medicine, PloS, American Psychological Association, Karger Journals, Wiley, Bentham Science) and 208 from Web of Science. After refinement, the search was restricted to 301 articles, 93 of which were obtained from the Newsletters' Website of CAPES and 208 from Web of Science. Initially, 75 articles were selected based on a title analysis; of these, only 22 articles were chosen because abstract and keyword analysis excluded several articles not meeting the inclusion criteria. Finally, 13 articles that were not available in its totality were excluded. Thus, 40 articles total were included in our qualitative synthesis, according to the flow diagram presented in Fig. 1.

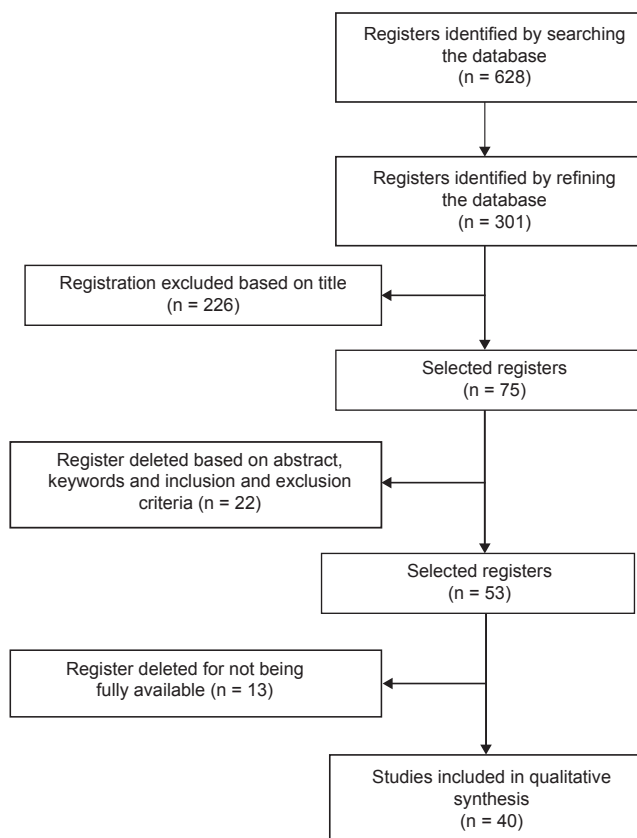


Fig. 1 – Flow diagram of the steps for article selection.

Discussion

Equipment and techniques for measuring handgrip

For grip strength evaluation there are several devices available, used both in clinical practice and in research. Main dynamometers are hydraulic, pneumatic, or digital.⁹ Table 1 shows the main dynamometers and their characteristics.

Among them, Jamar[®] hydraulic dynamometer (Fig. 2)¹² is the most mentioned in the literature, considered as the gold standard for the handgrip strength test.⁹ In this review, 19 (47.5%) studies were found to include this device as an instrument for measuring handgrip strength. On the other hand, the use of a pneumatic dynamometer was reported in 10 (25%) studies, and the use of a digital dynamometer was reported in 8 (20%) studies. In only 3 (7.5%) articles the type of equipment used was not cited, as can be seen in Tables 2 and 3.

The Jamar[®] device enables a discrete handle adjustment^{13,14} with 5 positions: I - 3.5 cm; II - 4.8 cm; III - 6.0 cm; IV - 7.3 cm; and V - 8.6 cm.¹⁵ From the papers documenting the use of Jamar[®] device, only three studies¹⁶⁻¹⁸ described the position adopted during the test application. Silva, Jones et al.¹⁶ standardized the position II for both genders; Escott, Ronald et al.¹⁷ and Bogoch, Escort et al.¹⁸ used positions II, III and IV for testing. However, none of these studies justified the criteria adopted for determining a position.

Studies were published¹⁹⁻²¹ that report the influence of the hand and handle sizes in the performance of grip strength.

Table 1 – Types of dynamometers and their characteristics.

Type of dynamometer	Measurement parameter	Handhold grip	Unit
Hydraulic	Maximum strength	With slight handle adjustment (5 different positions)	Newton
Pneumatic	Pressure	Without handle adjustment	mmHg
Digital	Maximum strength, time to peak strength, fatigue rate, area under the curve, rate of strength development	With or without continuous handle adjustment	Newton

N/C, Not cited; RH, Right hand; DomH, Dominant hand; Smax, Maximum strength.

**Fig. 2 – Jamar dynamometer.**

Source: Pamela D'Scalona, et al. (2009).¹²

The American Society of Hand Therapy establishes the position II as the standard handle size.²²

Pneumatic dynamometers are instruments that measure pressure, not manual strength. This pressure depends on the compression of air through a rubber bulb.²² This type of dynamometer lacks the feature of adjusting the grip, for compression. In this case, the pressure is dependent on the area where the strength is applied; thus, the size of the hand can influence the measurement.⁹ In the papers examined, three studies regulated the initial cuff pressure at 20 mmHg,^{3,23,24} other two studies regulated the initial pressure at 30 mmHg²⁵ or 40 mmHg². The other five studies did not show this information on the methodology session.

Digital dynamometers allow the evaluation of strength × time curve, providing other parameters for strength analysis, such as time to reach maximum strength, fatigue rate, and area under the curve, among others.^{26,27} This way of analyzing the strength is advantageous in the evaluation of hand disorders,²⁸ since one of the parameters considered as an indicator of manual dysfunction is the rate of strength development.²⁶

Regarding digital dynamometers, none of the studies (8 articles) presented the description of handle adjustment.

Some digital dynamometers feature continuous adjustment of the handle, allowing adaptation to the size of the hand and possible deformities present. This adjustment²⁶ is an important factor in strength performance, since the size of the hand influences the performance of the test.¹⁵

Protocols for handgrip measurement

Several aspects can affect the outcome of the handgrip test, and many of these are involved in defining the test application protocol, such as number of repetitions performed, type of feedback,²⁹ hand dominance, and fatigue.³⁰

By setting the protocol to be applied to the handgrip strength test, the contraction intensity shall be established: maximum or submaximal. In special populations, such as arthritic people, there are factors that can influence the intensity of the contraction election. The presence of pain, synovitis, erosion and joint deformity are direct factors; on the other hand, motivation, pain tolerance and use of analgesics are indirect factors.³¹

The test of maximum strength in arthritic people is considered a test of physical function based on individual performance, providing quantitative and reproducible information about the current state of patient and disease prognosis.³² This test is also used as a predictive measure of nutritional status,³³ morbidity and mortality.³⁴ The evaluation of maximum strength is well established in the literature, so that there is normative data for the healthy population.^{33,35} These data may serve as a comparison parameter to arthritic individuals; thereby the use of the maximum contraction intensity parameter has this advantage. Of the studies analyzed, 15 (37.5%) evaluated maximum strength only; the other studies did not present this information.

Regarding the number of test repetitions, 14 (35%) articles documented three attempts, 4 (10%) had only two repeats, and 22 (55%) did not report the number of repetitions performed. The recommendations of the American Society of Hand Therapists³⁶ and of the American Society for Surgery of the Hand³⁷ are that three steps are performed. However, there is disagreement in the form of analysis of such measures, which can be made from a single trial,²⁸ from the best obtained value,³⁸ or from values' average.² The average of three attempts has the highest test-retest reliability. Therapists and physicians suggest this form of analysis, rather than just an attempt, or the analysis of the best value among three attempts, both for clinical assessment of the patient and for research purposes.²² In the study from Haidar, Kumar et al.,³⁹ it was found that both the average of three attempts as the value of a single measurement showed high consistency, with no significant difference between methods.

Table 2 – Parameters of protocols for measuring handgrip in rheumatoid arthritis.

Reference (year)	Dynamometer type	Handgrip parameters				Strength analysis		
		Feedback type	Dominance	Repetitions	Contraction intensity		Acquisition time	Rest time
Ferraz et al. (1992)	Pneumatic	N/C	N/C	3	Smax	N/C	15 s	Average
Hakkinen, Malkia et al. (1997)	Jamar®	N/C	N/C	N/C	Smax	N/C	N/C	Average
Sugimoto, Takeda et al. (1998)	Pneumatic	N/C	N/C	N/C	N/C	N/C	N/C	Average
Fraser, Vallow et al. (1999)	Digital	Visual and verbal	N/C	3	Smax	N/C	1 min	Average
Torrems, Hann et al. (2000)	Pneumatic	N/C	N/C	N/C	N/C	N/C	N/C	N/C
Buljina, Taljanovic et al. (2001)	Jamar®	N/C	N/C	3	N/C	N/C	N/C	Average
Gordon, West et al. (2001)	Pneumatic	N/C	N/C	N/C	N/C	N/C	N/C	N/C
Häkkinen, Sokka et al. (2003)	Digital	N/C	N/C	N/C	Smax	N/C	N/C	Summation
Lefevre-Colau, Poiraudou et al. (2003)	Digital	N/C	N/C	3	N/C	N/C	1 min	Average
Poullis, Kretsi et al. (2003)	Jamar®	N/C	Only RH	N/C	N/C	N/C	N/C	N/C
Zijlstra, Heijnsdijk-Rouwenhorst et al. (2004)	Pneumatic	N/C	N/C	3	Smax	N/C	N/C	Average
Bodur, Yilmaz et al. (2006)	Jamar®	N/C	N/C	3	Smax	N/C	N/C	Average
Hakkinen, Kautiainen et al. (2006)	Jamar®	N/C	N/C	N/C	Smax	N/C	N/C	Average
Odegard, Landewe et al. (2006)	Jamar®	N/C	N/C	2	Smax	N/C	N/C	Average
Bearne, Coomer et al. (2007)	Digital	N/C	N/C	3	Smax	3 seg.	30 s	Average
Durez, Frassel et al. (2007)	Jamar®	N/C	N/C	N/C	Smax	N/C	N/C	N/C
Goodson, Mcgregor et al. (2007)	Digital	N/C	N/C	3	N/C	N/C	N/C	Average
Slatkowsky-Christensen, Mowinckel et al. (2007)	Jamar®	N/C	N/C	2	N/C	N/C	N/C	Average
Van Der Giesen, Nelissen et al. (2007)	Jamar®	Verbal	N/C	2	Smax	N/C	N/C	Average
Adams, Burridge et al. (2008)	Digital	N/C	N/C	N/C	N/C	N/C	N/C	N/C

N/C, not cited; RH, right hand; Smax, maximum strength.

Table 3 – Parameters of protocols for measuring handgrip in rheumatoid arthritis.

Reference (year)	Dynamometer type	Handgrip parameters manual					Strength analysis
		Feedback type	Dominance	Repetitions	Contraction intensity	Acquisition time	
Formisna, Van Der Sluis et al. (2008)	Jamar®	N/C	N/C	N/C	N/C	N/C	N/C
Oken, Batur et al. (2008)	Jamar®	N/C	N/C	N/C	N/C	N/C	N/C
Ronningen e Kjøyen (2008)	Digital	N/C	N/C	N/C	N/C	10 s	Average
Silva, Jones et al. (2008)	Jamar®	Verbal	N/C	3	N/C	N/C	Average
Silva, Lombardi et al. (2008)	Jamar®	N/C	N/C	N/C	N/C	N/C	N/C
Van Der Giesen, Nelissen et al. (2008)	Jamar®	Verbal	N/C	2	Smax	N/C	Average
Veehof, Taal et al. (2008)	Pneumatic	N/C	N/C	3	Smax	N/C	Average
Chung, Burns et al. (2009)	N/C	N/C	N/C	N/C	N/C	N/C	N/C
Chung, Burke et al. (2009)	N/C	N/C	N/C	N/C	N/C	N/C	N/C
Flint-Wagner, Lisse et al. (2009)	Digital	N/C	N/C	3	N/C	N/C	Average
Flipon, Brazier et al. (2009)	Jamar®	N/C	N/C	N/C	N/C	N/C	N/C
Mathieux, Marotte et al. (2009)	Pneumatic	N/C	Start DomH	N/C	N/C	N/C	N/C
Poole (2009)	Jamar®	N/C	N/C	3	Smax	N/C	Average
Escott, Ronald et al. (2010)	Jamar®	N/C	N/C	3	N/C	N/C	Average
Hayashibara, Hagino et al. (2010)	N/C	N/C	N/C	N/C	N/C	N/C	N/C
Jain, Ball et al. (2010)	Jamar®	N/C	N/C	N/C	N/C	N/C	N/C
Meireles, Jones et al. (2010)	Digital	N/C	N/C	N/C	N/C	N/C	N/C
Bogoch, Escort et al. (2011)	Jamar®	N/C	N/C	N/C	N/C	N/C	N/C
Nolte, Van Rensburg et al. (2011)	Pneumatic	N/C	N/C	N/C	N/C	N/C	N/C
Speed e Campbell (2012)	Pneumatic	N/C	Only RH	3	Smax	3 s	Average

N/C, not cited; RH, right hand; DomH, dominant hand; Smax, maximum strength.

The resting time interval between trials influences the performance of the strength, because this variable is directly related to muscle fatigue. Of the articles analyzed, 35 (87.5%) studies did not show the break time allowed in their methodology. Other authors have used intervals of 15s;⁴⁰ 30s;²⁴ 1 minute;^{41,42} and 2 minutes.² When comparing the resting time at 15 s, 30 s and 60 s, it was found that there was no significant difference between the three breaks in strength application, however, the decline in strength was lower at 60 s.⁴³ It is considered cautious a rest period of at least 1 minute, to counteract the effects of fatigue.^{28,31,39,43,44}

By analyzing the acquisition time of the handgrip strength test, it was found in 37 (92.5%) articles there was no description of this variable; in the remaining articles, three seconds,^{3,24} and ten seconds were used.⁴⁵ According to Kamimura and Ikuta,²⁸ there are few studies that focus on the influence of sustained strength time in the results. In a study comparing the contraction time of six vs. ten seconds, it was found that both showed a significant interclass correlation coefficient using a confidence interval of 95%.²⁸

It is known that there are differences in grip strength between the dominant and non-dominant hand. Studies reveal that the dominant hand has higher strength compared with the non-dominant hand;³⁰ there is also a relationship with gender, so that men have higher strength compared to women.⁴⁶ This difference between hands is about 10%.⁴⁴ In some handgrip protocols, hand dominance is considered and usually the test begins with the dominant hand.³⁹ Of the studies surveyed, 37 (92.5%) articles did not consider the hand dominance at the beginning of the test. Only Mathieux, Marotte et al.⁴⁷ specify that the participants must start the test with the dominant hand. Two studies evaluated the test on only one side – determining the protocol with only the right hand.^{2,14}

The last parameter analyzed refers to the feedback at the moment of the strength accomplishment, and that can contribute to achieve the best performance from the individual under consideration. Some authors adopted into their protocol the use of verbal feedback^{16,38,48} and others have adopted both verbal and visual feedback.⁴² Other studies (36 articles – 90%) reported no information about feedback. The use of feedback is a variable not well established in the literature involving individuals with arthritis, and also in other types of populations. There is a gap regarding the use of any type of feedback during handgrip strength tests; in this sense, Mathiowetz, Weber et al.²² raise the question of the influence of feedback on the outcome of grip strength.

Conclusion

Jamar dynamometer stands out as the most widely used type of dynamometer. As for the protocol, three repetitions at maximum intensity of contraction were reported. As for strength analysis, both average and best result were observed.

From this review, a great variability of handgrip protocols between studies was perceived, and in many of these studies the protocol used was not fully disclosed.

Conflicts of interest

The authors declare no conflicts of interest.

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