Measurement of handgrip strength - validity and reliability of the Saehan dynamometer

Assessment of hand grip strength - validity and reliability of the saehan dynamometer

Mauricio Moreira Reis, Paula Maria Machado Arantes

Study developed at FISA - Faculty itabirana Health Community Foundation of Higher Education Itabira Itabira, MG, Brazil.

[1] Teachers of Physiotherapy, Faculty of Health itabirana - Itabira (MG), Brazil.

ADDRESS CORRESPONDENCE TO :

Mauricio Moreira Reis - Villa technique gravel, 12 - Neighborhood gravel - CEP: 35900-841 - Itabira (MG), Brazil - E-mail: fisiomauricio@yahoo.com.br

PRESENTATION : sep. 2010

ACCEPTED FOR PUBLICATION : February 2011

SOURCE OF FUNDING : none

CONFLICT OF INTEREST : Nothing to declare

ABSTRACT

There is a great Variety of instruments available for Evaluating hand grip strength. There is, However, the Lack of studies showing the validity and reliability of most of these instruments. The purpose of this study was to examine the concurrent validity and test-retest reliability of the hydraulic dynamometer using the Saehan hydraulic and Jamar hydraulic dynamometers. One hundred healthy Subjects (50 men and 50 women), between the ages of 20 and 50 years old, without cognitive impairment, physical disability, orthopedic or neuromuscular dysfunction, and history of upper extremity injuries were tested with the Jamar and Saehan dynamometers. The concurrent validity between the Jamar and Saehan dynamometers both was excellent for the right hand *(r*=0.976) and the left hand *(r*=0986). Test-retest reliability was excellent for the both Jamar *(r*=0985 right and left hands) and the Saehan *(r*=0981 right hand and left hand *r*=0985). Saehan dynamometer is valid, reliable and comparable to the Jamar dynamometer. Therefore, the Saehan and Jamar dynamometers measure handgrip strength equivalently. As a result, strength values

obtained with the dynamometer, Saehan can be compared with reference values which were collected with the Jamar dynamometer.

Keywords : Dynamometer; handgrip strength; validity; reliability.

INTRODUCTION

Faced with the requirement to demonstrate the effectiveness of clinical procedures, it is essential that physical and occupational therapists prove the validity and reliability of their assessment instruments[1.] A valid and reliable assessment of handgrip strength is an important parameter to determine the effectiveness of various therapeutic strategies[2.3,] set treatment goals, assess the patient's ability to return to functional activities, and contribute to the development of research scientific[4.]

The measurement of handgrip strength by the dynamometer procedure consists of [5] simple, objective, practical and easy to use[6.] Recommended by the American Society of Hand Therapists (SATM)[7] and by the American Society for Surgery of the Hand (SACM)[8,] the Jamar dynamometer has been considered the most widely accepted instrument for assessment of handgrip strength[9-11,] with some studies presenting normative data[from 5.12 to 15.] There are two types of Jamar dynamometer, digital and hydraulic[16-20.] The literature recommends the use of the hydraulic model for the assessment of handgrip[21.22.] Several studies have reported high reliability and / or validity of this type of dynamometer[23-29] and, therefore, this model is considered the "gold standard"[27.29] and has been used by many researchers as a standard tool to validate other equipment measure of handgrip[18,23,26-31.]

There is a wide variety of commercially available instruments for the assessment of handgrip strength, including Saehan hydraulic dynamometer. This instrument resembles structurally and functionally to the Jamar dynamometer. However, there are no studies demonstrating its validity and reliability. According Fess[17,] the reliability and validity are essential to determine the effectiveness of an assessment tool. Reliability is defined as the extent to which a measure is consistent and[32] error-free. When an instrument is able to measure a variable accurately and consistently at different times, it is considered that this instrument has good intra-examiner reliability[32.] Shelf life is defined as the extent to which the instrument that measures to

be measured[32.] To be valid, an instrument must be reliable[17.] The most straightforward way of validity is concurrent validity. This indicates that the test results obtained with an instrument can replace the results of tests performed with an instrument "gold standard"[32.]

Some studies have used the Saehan hydraulic dynamometer to assess grip strength[33.34.] However, the psychometric properties of the measuring instrument yet to be established. Thus, this study aimed to assess the concurrent validity and intrarater reliability of the Saehan hydraulic dynamometer compared it with the Jamar hydraulic dynamometer. The importance of this research is the need to ensure that evaluation tools used in scientific research and clinical practice are valid and reliable. **The determination of these properties may be useful to clinicians and researchers who wish to use this instrument in clinical practice or research involving the measurement of handgrip strength, especially considering the accessibility of the dynamometer Saehan due to its lower cost compared to other dynamometers.** The evaluation of the validity of this dynamometer can also contribute to the normative data collected handgrip strength with the Jamar dynamometer can be used as reference to tests with the Saehan dynamometer.

METHODOLOGY

The study included 100 healthy subjects (50 men and 50 women) aged between 20 and 50 years of age (mean ± standard deviation, 29.39 ± 6.36 years), who agreed to participate by signing the Consent approved by the Ethics in Research. Individuals with any cognitive, physical, orthopedic and neuromuscular disorders and a history of upper limb injuries, which may affect handgrip strength, were not included in the study.

The hydraulic Jamar dynamometer (Sammons Preston Rolyan, 4 Sammons Court Bolingbrook, IL, 60440) and Saehan hydraulic dynamometer (Saehan Corporation, 973, Yangdeok-Dong, MasanHoewon-gu, Changwon 630-728, S. Korea) were used for the measurement of grip strength manual for each participant. Both dynamometers were calibrated before the start of data collection and their handles covered in the second position. This position is considered a standard by SATM is recommended in the literature for the tests of grip strength in clinical practice and research[7,21,22.]

Participants were divided into a group of men and women peers and a group of men and women unique. The handgrip right and left of the group of men and women pair was measured with the Jamar dynamometer first and then with the Saehan dynamometer. The groups of odd men and women was evaluated in opposite sequence (Table 1). The alternating sequence aimed to eliminate the influence of potential effects of muscle fatigue in[28] tests.

Tabela 1. Sequência da avaliação para os grupos de homens e mulheres pares e ímpares com os dinamômetros Jamar e Saehan

	Mão direita	Mão esquerda	Mão direita	Mão esquerda
GHMP	Jamar	Jamar	Saehan	Saehan
GHMI	Saehan	Saehan	Jamar	Jamar

GHMP: Grupo de homens e mulheres pares; GHMI: Grupo de homens e mulheres ímpares

Studies show that the results of testing handgrip strength may be influenced by changes in body position[35-38.] Thus, tests were performed in the recommended position SATM. Participants were comfortably seated in an armless chair with feet flat on the floor and hip and knee positioned at approximately 90 degrees of flexion. The shoulder of the tested limb was adducted and neutrally rotated, elbow flexed at 90 degrees, forearm and wrist in neutral position between 0 and 30 degrees of extension and from 0 to 15 degrees of adduction. The hand of the member not tested rested on the[seventh] leg on the same side (Figure 1). Participants were instructed to maintain the position during the tests and corrected by the examiner when necessary.

Figura 1. Posição recommendada pela ASHT (American Society of Hand). Therapists)

Accessories such as watches, bracelets, rings and bracelets were removed from both arms of the participants before the start of testing. All participants were evaluated individually and in a place reserved by the same examiner in the morning and afternoon. According to Figueiredo et al. [4]divergence of[10.39] results of several studies seem to indicate that the test of grip strength at various times of the day should not be cause for concern. He was given a demonstration of how the test should be conducted to familiarize with the equipment and the participants made a simulation test with performing submaximal force, then a period of one minute of rest before the official test. Participants were instructed not to look at the dial of the dynamometer to prevent any return *(feedback)* visual. No verbal command was given during the test and instructions for its implementation were standardized. During the instructions, the volume of the verbal command remained constant to avoid any influences the magnitude of muscle contraction[40.]

The test protocol was divided into two sections. In the first session of the tests were originally performed with his right hand and then with his left hand in a non-alternating, ie, three tests were run consecutively with his right hand and then three tests were done consecutively with the left hand. Participants were instructed to make a maximum contraction for 3 seconds in each test. There was a rest period of 30 seconds between each test and a rest period of 2 minutes between tests of each hand. This procedure was first made with one of the dynamometer, and after a rest period of 2 minutes, repeated with the other dynamometer. An interval of 10 minutes was given and the whole procedure performed in the first session was repeated in the second session.

Used was the mean of three tests for each hand to analyze the data. This procedure, recommended by SATM[7] and by Figueiredo et al. [4,] is considered the most reliable way of measuring handgrip[41.]

The concurrent validity between the Jamar dynamometer and Saehan and intra-examiner reliability of both dynamometers were calculated using the intraclass correlation coefficient (ICC). An ICC of 0.90 or higher is considered excellent, 0.75 to 0.90 good, 0.50 to 0.75 moderate, and less than 0.50 is considered poor[32.]

RESULTS

The mean values of grip strength, the right and left hands, collected with the Jamar dynamometer and Saehan are shown in Table 2.

Tabela 2. Valores médios da força de preensão para os dinamômetros Jamar e Saehan

	Mão direita				Mão esquerda			
	Jamar		Saehan		Jamar		Saehan	
	M	DP	M	DP	M	DP	M	DP
Homens (n=50)	39,50	5,77	41,39	4,35	38,40	3,53	39,02	10,25
Mulheres (n=50)	22,70	7,42	24,02	10,72	21,04	6,48	21,06	7,19

Dados são valores da média (M) e desvio padrão (DP). Valores de força de preensão manual expressos em quilograma força (kgf)

The concurrent validity between the Jamar dynamometer and Saehan was great for grip strength tests performed with the right hands *(r*=0.976) and left *(r*=0986).

The intra-examiner reliability was excellent for both the Jamar dynamometer and the Saehan dynamometer. (Table 3)

Tabela 3. Resultados do coeficiente de correlação intraclasse para os testes das mãos direita e esquerda com os dinamômetros Jamar e Saehan

	Mão direita	Mão esquerda
Jamar	0,985	0,985
Saehan	0,981	0,985

DISCUSSION

Several brands of dynamometers for the assessment of handgrip strength appeared in the domestic market in recent years. Some examples are the dynamometer TAKEY KIKI KOGIO TK[42] in 1201, the Model 136 dynamometer ENDVECO Smedley dynamometer[43] and[44.] However, there are no studies demonstrating the validity and reliability of most of these instruments. Face of the ongoing need to ensure that assessment instruments used in clinical practice are valid and reliable, it is essential for physical and occupational therapists prove the validity and reliability of their instruments of[an] assessment. The present study provides values for validity and reliability of the Saehan dynamometer based on data derived from tests performed handgrip in humans. **The advantage of using the Saehan dynamometer is its low**

price compared with the Jamar dynamometer, which makes it accessible to clinicians and researchers who wish to use this instrument in clinical practice or research development. Moreover, the Jamar dynamometer, considered the "gold standard" to evaluate the handgrip[27.29,] is available only in the international market and are no longer marketed in Brazil.

Evaluation of handgrip strength using the Jamar dynamometer is considered the standard by which all other instruments should be compared[from 9.26 to 31.] One reason for this choice is the high validity and reliability of this instrument has[23-29.]

According Fess[17,] the reliability and validity are essential to determine the effectiveness of an assessment tool. The stronger statistical tool for this analysis is the ICC, which with only one coefficient is measured not only the correlation between two variables, but the correlation, ie, the degree to which the data is the same[45.]

The results of this study show the comparability of measurements with the Saehan dynamometer recognized Jamar dynamometer. The data collected showed an excellent intra-examiner for the Jamar dynamometer *(r*=0985 right and left hands) and Saehan *(r*=0981 right hand and left hand *r*=0985), indicating that the results of tests of grip strength performed with both dynamometers were consistent. Previous studies have reported high values of intra-examiner reliability, varying from 0.97 to 0.99 for other assessment tools handgrip, including[28] Baseline dynamometers, Roylan[27, 31] and Dynex BTE-Primus grip tool[29.] The concurrent validity of the Jamar dynamometer and the Saehan dynamometer was excellent for the tests performed with the right hands *(r*=0.976) and left *(r*=0986), indicating that both dynamometers measure the same construct of handgrip. Other studies used the Jamar dynamometer as a criterion standard, comparing it with various assessment tools handgrip to determine the concurrent validity, with values ranging from 0.901 to 0.99[18,23,27-29,31.]

The exchange between dynamometers for the assessment of handgrip strength should never be practiced. The present study used a Jamar dynamometer and a Saehan dynamometer. We can't say that all Jamar and Saehan dynamometers measure a manner equivalent to less than its concurrent validity with known weights is demonstrated. Similarly, because there is evidence that different versions of the Jamar dynamometer not always measured equivalently[24,] it can be stated for the

same Saehan dynamometer. Thus, it should be used dynamometer for assessing the patient and review, when one wishes to obtain comparative measurements[24].

The evaluations were performed with the handles on both dynamometers regulated in the second position. Future studies should determine whether the tests with the first, third, fourth and fifth positions of the handle of the Saehan dynamometer are valid and reliable when compared to tests with the same positions of the Jamar dynamometer. Data collection was performed by only one evaluator, so no conclusions can be drawn with respect to inter-rater reliability of the Saehan dynamometer. Finally, the results should not be generalized to children and elderly, as these age groups were not included in the study.

CONCLUSIONS

Saehan hydraulic dynamometer is valid, reliable and comparable with the Jamar hydraulic dynamometer when set in the second position, when properly calibrated and standardized positioning and instructions are adopted for the testing of handgrip. Therefore, data collected with the Jamar dynamometer are equivalent to data collected with the Saehan dynamometer. Consequently, normative data for hand grip strength Jamar dynamometer can be used as reference to tests with the Saehan dynamometer.

REFERENCES

1. *Hammond R. Evaluation of physiotherapy by measuring outcome. Physiotherapy. 2000;86(4):170-2.*

2. *Bowen IJ, Sosa DM. Value of hand strenght in healthy adults. Bol Med Postgrado. 2001;17(2):57-68.*

3. *Incel NA, Ceceli E, Durukan PB, Erdem HR, Yorgancioglu ZR. Grip Strength: Effect of Hand Dominance. Singapore Med J. 2002;43(5):234-7.*

4. *Figueiredo IM, Sampaio RF, Mancini MC, Silva FCM, Souza MAP. Test of grip strength using the Jamar dynamometer. Acta Fisiatr. 2007;14(2):104-10.*

5. *Rauch F, Neu CM, Wassmer G, Beck B, Rieger-Wettengl G, Rietschel E, Manz F, Schoenau E. Muscle analysis by measurement of maximal isometric grip force: New reference data and clinical applications in pediatrics. Pediatr Res. 2002;51(4):505-10.*

6. *Moreira D, Alvarez RRA, Gogoy JR, Cambraia AN. Abordagem sobre preensão palmar utilizando o dinamômetro JAMAR®: uma revisão de literatura. R. Bras. Ci. e Mov. 2003;11(2):95-9.*

7. *Fess EE. Grip strength. In: Casanova JS. Clinical Assessment Recommendations. 2nd ed. Chicago: American Society of Hand Therapists, 1992:41-45.*

8. *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.*

9. *Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers, S. Grip and pinch strength: Normative data for adults. Arch Phys Med Rehabil. 1985;66(2):69-74.*

10. *Bechtol CO. The use of a dynamometer with adjustable handle spacings. J Bone Joint Surg. 1954;36A(4):820-4.*

11. *Stephens JL, Pratt N, Parks B. The reliability and validity of the Tekdyne hand dynamometer: Part I. J Hand Ther. 1996;9(1):10-17.*

12. *Budziareck MB, Duarte RRP, Silva MCGB. Reference values and determinants for handgrip strength in healthy subjects. Clin Nutr. 2008;27(3):357-62.*

13. *Günther CM, Bürger A, Rickert M, Crispin A, Schulz CU. Grip strength in healthy caucasian adults: reference values. J Hand Surg [Am]. 2008;33(4):558-65.*

14. *Peolsson A, Hedlund R, Oberg B. Intra- and inter-tester reliability and reference values for hand strength. J Rehab Med. 2001;33(1):36-41.*

15. *Schlüssel MM, Dos Anjos LA, De Vasconcellos, MTL, Kac G. Reference values of handgrip dynamometry of healthy adults: a population-based study. Clin Nutr. 2008;27(4):601-7.*

16. *Fess EE. A method for checking Jamar dynamometer calibration. J Hand Ther. 1987;1:28-32.*

17. *Fess EE. The need for reliability and validity in hand assessment instruments. J Hand Surg [Am]. 1986;11(5):621-3.*

18. *Beaton DE, O'driscoll SW, Richards RR. Grip strength testing using the BTE work simulator and the Jamar dynamometer: a comparative study. J Hand Surg [Am]. 1995;20(2):293-8.*

19. *Clerke A, Clerke J. A literature review of the effect of handedness on isometric grip strength: differences of the left and right hands. Am J Occup Ther. 2001;55(2):206-11.*

20. *Taylor C, Shechtman O. The use of the rapid exchange grip test in detecting sincerity of effort, Part I: administration of the test. J Hand Ther. 2000;13(3):195-202.*

21. *Bear-Lehman J, Abreu BC. Evaluating the hand: issues in reliability and validity. Phys Ther. 1989;69(12):1025-33.*

22. *Jones LA. The assessment of hand function: a critical review of techniques. J Hand Surg [Am]. 1989;14(2):221-8.*

23. *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.*

24. *Flood-Joy M, Mathiowetz V. Grip strength measurement: a comparison of two instruments. Occup Ther J Res. 1987;7:235-43.*

25. *Hamilton A, Balnave R, Adams R. Grip strength testing reliability. J Hand Ther. 1994;7:163-70.*

26. *Hamilton GF, Mcdonald C, Chenier TC. Measurement of grip strength - validity and reliability of the sphygmomanometer and Jamar grip dynamometer. J Orthop Sports Phys Ther. 1992;16:215-9.*

27. *Mathiowetz V. Comparison of Rolyan and Jamar dynamometers for measuring grip strength. Occup Ther Int. 2002;9(3):201-9.*

28. *Mathiowetz V, Vizenor L, Melander D. Comparison of baseline instruments to the Jamar dynamometer and the B&L engineering pinch gauge. Occup Ther J Res. 2000;20:147-62.*

29. *Shechtman O, Davenport R, Malcolm M, Nabavi D. Reliability and validity of the BTE-Primus grip tool. J Hand Ther. 2003;16(1):36-42.*

30. *Brown A, Cramer LD, Eckhaus D, Schmidt J, Ware L, Mackenzie E. Validity and reliability of the dexter hand evaluation and therapy system in hand-injured patients. J Hand Ther. 2000;13(1):37-45.*

31. *Shechtman O, Gestewitz L, Kimble C. Reliability and Validity of the DynEx Dynamometer. J Hand Ther. 2005;18:339-47.*

32. *Portney LG, Watkins MP. Foundations of Clinical Research: Applications to Practice. 2nd ed. Norwalk, CT: Appleton & Lange; 2000.*

33. *Häkkinen A, Rinne M, Vasankari T, Santtila M, Häkkinen K, Kyröläinen H. Association of physical fitness with health-related quality of life in Finnish young men. Health Qual Life Outcomes. 2010; 29;8:15.*

34. *Fairhall N, Aggar C, Kurrle SE, Sherrington C, Lord S, Lockwood K, Monaghan N, Cameron ID. Frailty Intervention Trial (FIT). BMC Geriatr. 2008;.13;8:27.*

35. *Ng GYF, Fan ACC. Does elbow position affect strength and reproducibility of power grip measurements? Physiotherapy. 2001;87(2):68-72.*

36. *Oxford KL. Elbow positioning for maximum grip performance. J Hand Ther. 2000;13(1):33-6.*

37. *Richards LG. Posture effects on grip strength. Arch Phys Med Rehabil. 1997;78(10):1154-6.*

38. *Richards LG, Olson B, Palmiter TP. How forearm position affects grip strength. Am J Occup Ther. 1996;50(2):133-8.*

39. *Mcgarvey SR, Morrey BF, Askew LJ, An KN. Reliability of isometric strength testing: temporal factors and strength variation. Clin Orthop Res. 1984;185:301-5.*

40. *Johansson CA, Kent BE, Shepard KF. Relationship between verbal command volume and magnitude of muscle contraction. Phys Ther. 1983;63(8):1260-5.*

41. *Stratford PW. Summarizing the results of multiple strength trials: truth or consequence. Physio Can. 1992;44:14-8.*

42. *Barbosa AR, Souza JMP, Lebrão ML, Laurenti R, Marucci MFN. Functional limitations of Brazilian elderly by age and gender differences: data from SABE Survey. Caderno de Saúde Pública. 2005;21(4):1177-85.*

43. *Esteves AC, Reis DC, Caldeira RM, Leite RM, Moro ARP, Borges Jr, NG. Força de preensão, lateralidade, sexo e características antropométricas da mão de crianças em idade escolar. Revista Brasileira de Cineantropometria & Desempenho Humano. 2005;7(2): 69-75.*

44. *Frederiksen H, Hjelmborg J, Jakob Mortensen Mcgue M.; Vaupel JW, Christensen K. Age Trajectories of Grip Strength: Cross-sectional and Longitudinal Data Among 8,342 Danes Aged 46 to 102. Ann Epidemiol. 2006;16(7):554-62.*

45. *Kramer MS, Feinstein AR. Clinical biostatistics: LIV. The biostatistics of concordance. Clin Pharmacol Ther. 1981;29:111-23.*