Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/9042
DOI URL: http://dx.doi.org/10.21474/IJAR01/9042

RESEARCH ARTICLE

TEST-RETEST RELIABILITY OF ELECTRONIC HAND DYNAMOMETER IN HEALTHY ADULTS.

Paramasivan Mani[1], Kiruthigadevi Sethupathy[2] And Amal K Francis[3].

1. Paramasivan Mani Ph.D. Teaching Faculty King Saud Bin Abdulaziz University for Health Sciences.
2. Kiruthiga devi Sethupathy, MPT NeuroPhysiotherapy Specialist, Al - Ahsa hospital Saudi Arabia.
3. IMDC Hospital, Maldives.

Manuscript Info

Manuscript History
Received: 10 March 2019
Final Accepted: 12 April 2019
Published: May 2019

Key words:-
grip strength, reliability, hand dynamometer, with and without Boolean operators 'and', 'in'.

Abstract

Background: Physical Therapists frequently measure grip strength by using hand dynamometer. The tests establish a baseline from which to assess improvement, compare the effectiveness of various surgical or treatment procedures, set realistic treatment goals, and assess a patient's ability to return to previous employment. Recently, researchers have come up with an instrument, Electronic Hand dynamometer, to measure maximal isometric grip strength. However the reliability of Camry electronic hand-held dynamometer has not been reported.

Need of the study: The purpose of this study is to describe the test-retest reliability of Camry electronic hand dynamometer for grip-strength measurement.

Objectives:

To estimate the reliability of grip strength measurements obtained with the electronic hand dynamometer in healthy adults.

To compare the reliability of electronic hand dynamometer in various positions of both arms, i.e., flexed and extended elbow.

Results: A total of 114 participants were included in this study from Mysore city. The included samples were divided into six groups according to age with 19 samples in each group. ICC was found to be .95. The reliability of the electronic hand dynamometer for the right side with the elbow flexed was found to be 0.94 while for left side was found to be 0.91. Meanwhile, the reliability for the right side with elbow extended was found to be 0.98 and for the left side was 0.97.

Conclusion: The findings of this study demonstrate that Camry electronic hand dynamometer has excellent reliability to test grip strength. The reliability of the instrument was found to be the best when grip strength was measured in elbow extended position.

Introduction:-

Physical Therapists frequently measure grip strength by using hand dynamometer. The tests establish a baseline from which we can assess improvement, compare the effectiveness of various surgical or treatment procedures, set realistic treatment goals, and assess a patient's ability to return to previous employment.[(1)]There are 35 muscles involved in movement of the forearm and hand, with many of these involved in gripping activities. During gripping

Corresponding Author:-Paramasivan Mani.
Address**:-**Paramasivan Mani Ph.D. Teaching Faculty King Saud Bin Abdulaziz University for Health Sciences.

activities, the muscles of the flexor mechanism in the hand and forearm create grip strength while the extensors of the forearm stabilize the wrist and hand. There are four major joints of hand namely carpometacarpal, inter metacarpal, metacarpophalangeal, and inter phalangeal joints, with 9 extrinsic muscles that cross the wrist and 10 intrinsic muscles with both of their attachments distal to the wrist. These muscles include the pronator teres, flexor carpi radialis, flexor carpi ulnaris, flexor sublimis digitorum, and palmaris longus on the extrinsic layer and the flexor profundus digitorum, flexor pollicis longus, pronator quadratus, flexor pollicis brevis, and abductor pollicis brevis on the intrinsic layer.(2) Each of these muscles is active during gripping activities.

Hand strength is often affected by injury or disease and therefore measurement of grip strength is critical for Physiotherapists and other health professionals for assessment of disease progress and progression in rehabilitation.(3) Hand-grip dynamometry is a useful assessment tool for multiple purposes in clinical practice, including the assessment of upper limb impairment; in evaluating work capacity for those with hand injuries and other work related injuries; the evaluation of people with other impairments and disabilities such as rheumatoid arthritis, chronic fatigue syndrome, developmental disabilities, muscular dystrophy and stroke; determining the efficacy of different treatments for people with a range of disabilities; part of an overall fitness assessment; and in determining the level of effort exerted.[3,4]

When testing grip strength, there are many variables that need to be normalized before the actual procedure. The testing protocols need to be consistent with regards to time of day, posture, anthropometric measures and dynamometer adjustments. Posture and elbow positioning during handgrip testing has also been found to play an important role in the strength results. (3)Any evaluation used to measure hand strength must be reliable and valid i.e., reproducible results with repeated measurements under the same conditions. This is normally enhanced by the use of standard methods of grip strength evaluation. There are a variety of methods available to check strength. They are a pneumatic instrument with air compression bulb, a spring device that depends on compression of steel spring to register the amount of compression and a sealed hydraulic system to register the force in pounds. (1) Even though all the methods are being used to evaluate grip strength, grip strength measurement using hand dynamometer has shown maximum reliability as compared to other methods. Moreover, the first two methods measure only the pressure of the grip and not the force. (3)

Recently, researchers have come up with an instrument, Camry Electronic Hand dynamometer, to measure maximal isometric grip strength. Added advantage of this Electronic hand-held dynamometer is, it can auto capture maximum achieved grip power which can be calibrated to 200 lbs (90 kg) and display the value. (4) It can assess results according to age and gender as well as compare current records to the prior one. Since the values are auto captured within the instrument, the examiner need not keep up his/her stationary position. The instrument is adjustable with grip sizes to account for varying hand sizes. It has a digital LCD read-out, with on screen rating of results according to age and gender, the instrument saves and stores results for fast retrieval with up to 19 users. (4) Moreover it is economical in comparison to study instrument like Jamar and Baseline. Grip dynamometer measures the maximum voluntary effort by the participant. Hence, even though the instrument is precise, internal threats to validity may persist. Therefore, it is necessary to assess test-retest reliability of the measurement to control its test trial variability. The manufacturer has recommended two positions of testing. The more reliable position must be determined.

Reliability studies of Camry electronic hand dynamometer showing optimal positions of arm have not been conducted. Hence, the purpose of this study is to determine the reliability of the Camry electronic hand dynamometer.

Materials and methods:

A prospective study, was conducted between February 2019 and April 2019 in an NGHA outpatient department, Physiotherapy and Rehabilitation Center, Al ahsa, Saudi Arabia. Patients were referred by Orthopaedics, Neurology department and also self –referral to the centre. Patients were included if they were between 17 to 65 years of age.

2.1. Inclusion criteria:

1. Normal adults of 17 years of age and above
2. Both male and female adults

2.2. Exclusion criteria:

1. Adults with any past history of hand injury, neurological deficits, visual or auditory dysfunctions

2. Degenerative disease , any previous history of fracture and joint disease
3. Subjects with any upper limb pain syndrome
4. Subjects with any cervical pathology

2.3. Materials used:

1. Camry Electronic Hand Dynamometer
2. Chair
3. Pen
4. Paper

2.4 Procedure:

Ethical clearance from JSS medical college was obtained. Written consent was obtained from the participants prior to the commencement of the study. At the beginning of the study, demographic data (age, sex, dominant hand) was obtained and recorded. A total of 114 samples were divided into 6 groups of 19 samples in each group according to age. The participants were explained in detail about the procedure. Demonstration of the procedure by Examiner as per the American Society of Hand Therapist (ASHT) recommended standardized position for grip strength [(12)].

Sitting position in a straight back chair with both feet flat on the floor was the starting position. The hand to be tested was placed on their ipsilateral thigh, shoulder adducted to zero degree and neutral rotation. It was measured with elbow in two positions i.e., elbow at right angle to the shoulder and elbow in extended position with arm hanging by the side. [(12)] The handle of the dynamometer was adjusted with the base resting metacarpal (heel of palm), while the hand rested on middle of four fingers. Demonstration of maximum hand grip strength by examiner was given to each participant before they were asked to do it themselves. The participants were asked to squeeze the dynamometer with maximum isometric effort, which was maintained for about 5 seconds. No other body movement was allowed. Participants were asked to do a practice section before the actual test commencement followed by 5minutes rest period. [(12)]

Participants were asked to perform 3 attempts with a rest period of 30 seconds Between each attempt. No feedback regarding performance was given however the participants were encouraged consistently by instructing the participants to "squeeze harder . .. harder". [(3)] The reading of the three trials was recorded and average was taken. Retest was done the next day at the same time with the same procedure and average of the retest readings was taken. Before the attempt, warm up was done. [(18, 17)] Then the other procedure after a rest of 15minutes for both the hands was performed. [(6)]

Plate 1:-Test position – Elbow flexed to 90 degree

The flow chart of the procedure: the steps for the procedure is depicted below-

Informed Consent Was Taken From The Participants

Grip Strength Of Both Hands Was Measured With Elbow In Two Different Positions Using Electronic Hand

Three Trials Were Recorded

The Same Procedure Was Repeated On The Next Day

Averages Of These Readings Were Considered

Figure 2:-Flow Chart Of The Procedure

Plate 2:-Test position- Elbow extended

Data Analysis

SPSS software 23.0 was used for statistical analysis. Descriptive statistics were calculated. Pearson's correlation was used to find the correlation between two of the three trials which were considered. ICC was calculated to evaluate the degree of agreement of participants' scores on both occasions. SEM was used to evaluate the measurement precision and convey information about the magnitude of measurement.

Results:-

A total of 114 participants were included in this study. The included samples were divided into six groups according to age with 19 samples in each group. Relative and absolute reliability were calculated. Descriptive statistics are presented in Table 1. Reliability is expressed by the correlation coefficient which ranges from 0 to 1 with 0 showing no reliability and 1 showing perfect reliability. Any measure should have an intra-class correlation coefficient (ICC) of at least 0.6 to be useful.[21] ICC, in the present study, was found to be 0.95.The reliability of the electronic hand dynamometer for the right side with the elbow flexed was found to be 0.94 while for left side was found to be 0.91. Meanwhile, the reliability for the right side with elbow extended was found to be 0.98 and for the left side was 0.97. Relative and absolute reliability measures are listed in the table 2 below.

Table 2:-Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EFR1	230	9.10	54.50	27.9039	10.28277
EFRR1	228	11.00	54.30	27.7627	10.07811
EER1	228	10.70	54.20	27.4732	10.10929
EERR1	228	10.20	53.20	26.8022	9.96340
EFL1	228	3.20	50.10	24.6632	9.22991
EFLR1	228	9.90	51.10	23.9412	8.88406
EEL1	228	9.10	48.20	24.0114	8.85162
EELR1	228	9.10	50.10	23.3355	8.37791

Mean and standard deviation of the two trials were considered.

Table 3:-Relative and absolute reliability measures

		Coefficient of variance	Standard error of measurement	Interclass correlation coefficient	Test–retest reliability	
	EFR1	36.84	2.30		REF	.94
RIGHT	EFRR1	36.27	2.25		REE	.98
	EER1	36.76	2.26			
	EERR1	37.16	2.23			
				.95		
	EFL1	37.38	2.06		LEF	.91
LEFT	EFLR1	37.09	1.98		LEE	.97
	EEL1	36.85	1.98			
	EELR1	35.87	1.87			

Discussion:-

For all the testing devices used in clinical practice it is important to have accurate and reliable results. There is a wide range of devices available for measuring hand grip strength and both accuracy and reliability would vary depending on quality and design of the device as well as the testing protocol used and how well these are enforced by the tester.

The results of this study demonstrated excellent test-retest reliability of electronic hand dynamometer in healthy adults. The instrument used was Camry electronic hand dynamometer. This instrument provided stable and similar measurements at the two occasions on which the grip strength was tested.

Many studies have investigated the effect of various body positions on grip strength measurements. In this study the position used was sitting upright on a chair. This position is found to be the maximum force generating posture compare to supine or standing [15].

A total of 114 samples were divided into 6 groups of 19 samples in each group according to age. Three trials were performed on both the occasions of strength testing on both sides. The mean of the three trials were taken for the strength measurements to be accurate. Out of the three trials, first two were considered after correlation since there were chances errors with the correlation of the third trial due to muscular fatigue. [8] The measurement procedures were performed with elbow in two positions: flexed and extended. With an interval of one day between the two testing occasions, the ICC was found to be 0.95 which is considered to be excellent according to Shrout's classification. [13] The reliable measurement of the electronic hand dynamometer was indicated by the high value of the ICC score.[11.18,19]

The highest mean grip-strength measurement in the present study was found when the elbow joint was placed in 0 degree of flexion i.e. fully extended position as compared to elbow flexed at 90 degrees. The reliability of the instrument was found to be better in elbow extended position than the elbow flexed position with a score of 0.98 for the extended position in both the right and left arms. Participants too felt the fully extended position was easier for them to perform the action. This is supported by the study done by Kuzala et al on grip strength measurement in elbow flexed and extended position and found better scores of grip strength in the elbow extended position than the elbow at 30, 45, 90 and 135 degrees of flexion.

When the elbow joint is in a flexed position, the angular variations during the procedures may affect the test-retest reliability .Whereas in the elbow extended position, i.e. the close pack position of elbow, the joint gains maximum stability and thus the measurement errors can be minimized which can lead to good test- re test reliability. [14]As compared to the other standard hand dynamometer, the Camry electronic hand dynamometer is economically cheaper and easily available.

The procedure to check grip strength using this equipment is comfortable and easy. [6] Also, the instrument used in this study weighs 450 grams, smaller in size which makes it easier to handle during the test. The grip portion of the gauge is adjustable via a central thumb-head and can be precisely and repeatedly adjustable. It is easier to setup the unit and there are 19 definable users with options for gender, age to store, along with ability to recall test results for each user. The unit also compares each individual test run for each of 19 users and displays the incremental increase or decrease from the last record. It is easy to switch from pounds to kilograms at any time, including for previously stored data. Each test done will also rate the performance by displaying weak, normal or strong based on their age and gender. This recall facility can be utilized as a biofeedback for the patient undergoing hand rehabilitation in non-clinical setup. So, the Camry electronic hand dynamometer complies with the patients' need to assess the grip strength in a convenient manner. Thus, it is recommended for patients with hand dysfunction in clinical practice.

Limitations and suggestions:

1. Fatigue was a limiting factor since there was short rest period given between trials which may have affected the scores.
2. Further research can be performed to compare the reliability of different types of dynamometers for various shoulder and wrist positions correlating with the elbow positions.

Conclusion:-

Test-retest reliability of the Camry electronic hand dynamometer showed excellent reliability and the scores were the best when the elbow was held in fully extended position during the testing procedure.

Clinical Implication

Camry electronic hand dynamometer is a reliable instrument for grip strength measurement among healthy adults of all age groups. Hence it can be used as a part of assessment in clinical practice.

References:-

1. Trombly C. Occupational therapy for physical dysfunction. 2nd ed. Baltimore: Williams & Wilkins. 1983.

2. Kirk P. Evaluation of grip loss. Cal Med. 1956; 85: 314-320.
3. Bechtol C. Grip test: The use of a dynamometer with adjustable handle spacings. JBone Joint Surg AM. 1995; 36: 820-832.
4. Roberts H, Denison H, Martin H, Patel H, Syddall H, Cooper C, Sayer A et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardized approach. Age Ageing. 2011; 40 (4): 423-429.
5. Mathiowetz V, Weber K, Volland G, Kashman N. Reliability and validity of grip and pinch strength evaluation. J. Hand Surg. 1984; 9A: 22-6.
6. Bohannon R. Test-retest reliability of hand-held dynamometry during a single session of strength assessment. Phys Ther. 1986 Feb; 66(2):206-9.
7. Kuzala E, Vargo M. The relationship between elbow position and grip strength. Am J Occup Ther. 1992 June; 46(6): 509-512. Hamilton A, Balgave R, Adams R. Grip strength testing reliability. J Hand Ther. 1994, Jul-Sep; 7(3): 163-70.
8. Coldham F, Lewis J, Lee H. The reliability of one v/s three grip trials in symptomatic and asymptomatic subjects. J Hand Ther. 2006 Jul-Sep; 19(3):318-26.
9. Molenaar M, Zuidam J, Selles R, Stam H, Hovins E. Age-specific reliability of two grip strength dynamometer when used by children. J Bone Joint Surg. 2008 May; 90: 1053-1059.
10. Reuter S, Massy-Westropp N, Evans A. Reliability and validity of indices of hand grip strength and endurance. Aust Occup Ther J. 2011 Apr; 58(2):82-7.
11. Reddon J, Stefanyank W, Gill D, Renney C. Hand dynamometer; Effects of trials and session., Percept Mot Skills.1985 Dec; 61:1195-8.
12. USA. American Society of Hand therapists Monograph. Clinical assessment recommendations. Indianapolis.
13. Shrout P, Fleiss J. Intraclass correlations: Uses in assessing rater reliability. Psych Bulletin. 1979; 86(2):420-428.
14. Teraoka T. Studies on the peculiarity of grip strength in relation to body positions and aging. Kobe Journal of Medical Science. 1979; 25: 1-17.
15. Wiles J, Boyson H, Bird S. Validity and reliability of a new isometric hand dynamometer. Sports Eng. 2001; 4: 147-152.
16. Savva C, Giakas G, Efstathiou M, Karagiannis C. Test-retest reliability of handgrip strength measurement using a hydraulic hand dynamometer in patients with cervical radiculopathy. J Manipulative Physiol Ther. 2014; 37: 206-210.
17. Marion R, Niebuhr B. Effect of warm-up prior to maximal grip contractions. J Hand Ther. 1992: 143–6.
18. MacDermid J, Alyafi T, Richards R, Roth J. Test–retest reliability of isometric grip strength and endurance grip tests performed on the Jamar and NK devices. Physiother Can. 2001; 53(1): 48–54.
19. Innes E. Handgrip strength testing: a review of the literature. Aust Occup Ther J.1999; 46: 120–40.
20. Walter D, Elisaziw M, Donner A. Sample size and optimal designs for reliability studies. Star Med. 1998; 17(1):101-110.
21. Chinn S. Repeatability and method comparison. Thorax. 1991; 46: 454-456.