Serial Grip Strength Testing- Its Role In Assessment Of Wrist And Hand Disability

L Ashton, S Myers

Citation

L Ashton, S Myers. *Serial Grip Strength Testing- Its Role In Assessment Of Wrist And Hand Disability*. The Internet Journal of Surgery. 2003 Volume 5 Number 2.

Abstract

Handgrip strength testing has long been used as a tool in the clinical assessment of hand and wrist injury. Of particular interest have been attempts to utilise strength testing to detect sincerity of maximum voluntary effort. This has particular relevance to monetary payment in worker's compensation, motor vehicle accident and medical insurance claims. This paper recommends using the Jamar dynamometer as a measurement tool because it is the most widely researched and reported grip strength measurement device available. It also looks at the different tests developed to determine an individual's level of effort during grip strength testing. A protocol is suggested for a time and cost efficient grip strength assessment that should be used in conjunction with clinical acumen when assessing hand and wrist disability.

INTRODUCTION

Grip strength measurements have a variety of clinical applications: assessment of chronic disability, response to treatment, work capacity post hand injury, and in determining the sincerity of effort. An objective measure of the sincerity of effort has particular relevance in the assessment of workers compensation, motor vehicle accident, disability insurance and medical negligence claims.

This paper analyses the literature regarding the current measurement devices available and the various tests currently in use to assess patient effort. A simple and efficient protocol is suggested to assess patient grip strength effort.

MEASUREMENT DEVICES

Many measuring devices are available:

1. Hydraulic instruments are sealed systems that measure grip strength in kilograms or pounds of force. The most widely used is the Jamar dynamometer26,30. It is inexpensive, simple to use, versatile in its applications, and has been found to be accurate6and reproducible10,22 in its measurements. It is the most widely used and reported upon device.

2. Pneumatic instruments, for example the modified sphygmomanometer, rely on compression of an air filled compartment, and thereby measure grip pressure rather than grip strength. The limitation is that varying the surface area over which pressure is applied leads to variable results (i.e. larger hand size leads to artificially lower results than smaller hand size)7.

3. Mechanical instruments, for example the Stoelting dynamometer25, measure grip strength through the tension produced in a steel spring and read in kilograms or pounds of force. Strain gauges measure in Newtons of force and include the Isometric Strength Testing Unit21. These devices have not been widely reported on in the literature and are not considered as accurate and reproducible in their measurements.

Figure 1

Figure 2

Figure 3

RECOMMENDED TESTING POSITION

A standard position for testing recommended by the American Society of Hand Therapists[25] requires that the patient:

- Sit in a straight-backed chair
- Feet flat on the floor
- Shoulders adducted in neutral
- Arms unsupported
- Elbows flexed at 90 degrees
- Forearm rotation neutral
- Wrist 0-30 degrees dorsiflexion and 0-15 degrees ulnar deviated

Variations from this position significantly influence results.

Figure 4

Figure 5

ENSURING TESTING ACCURACY AND REPRODUCIBILITY

MAXIMUM GRIP STRENGTH MEASUREMENT

The Jamar dynamometer is a variable hand span instrument with five different positions for measurement. Maximal grip strength most commonly occurs in the second or third position and is usually tested at the second position (3.8cm)[20]

NUMBER OF TRIALS

No significant difference was noted when measuring maximum grip strength between 1 trial, 3 trials and an average of 3 trials[12]. We recommend the use of a single measurement as accurate and time efficient

REST PERIOD BETWEEN TRIALS

Mathiowetz et al[19] found no significant differences in grip measures when using 15, 30 and 60 second rest periods between measurements[32]. Rest periods occur during testing when changing measurement positions and alternating hands. These resting periods are adequate for accurate measurement.

NORMATIVE DATA

Most normative data studies use the Jamar dynamometer. Large variations have been found in nationality based studies which have not adequately controlled for work and leisure persuits[5]. Minimal normative data exists for subjects with disabilities, and the measured standard deviations have been large. Consequently currently available measurement norms are limited in their applicability[19].Some generalisations however may be made:

1. Male grip strength exceeds female grip strength by 35-70%
2. Grip strength increases with age to peak between 30 and 45 years after which strength decreases3
3. There is a positive correlation between grip strength, body weight and height up to 98kilograms and 190centimeters28
4. The dominant hand is usually 10% stronger than the non-dominant hand (different studies range from 0-10% difference)24. Left handed individuals show approximately the same strength in both hands4

TESTS USED IN ASSESSING PATIENT EFFORT SINCERITY

REPEAT TESTING

Janeda et al[15] found maximal effort grip strength variation should always be less than 10%. Ashford[2] found repeat testing was not a useful way to discriminate between maximal and submaximal effort. This test is at best equivocal as a means of determining sincerity and should not be used alone.

FIVE HANDLE POSITION TEST (5HPT)

This test measures grip strength at each of the 5 Jamar positions. When measurements are graphed a Bell curve peaking at position 2 or 3 should result. Stokes et al31 found maximal effort produces a Bell curve, and submaximal effort produces a flat line. Firrell and Crain8 agreed but added that in a small number of subjects the Bell curve peaked in other positions. Niebuhr and Marion23held that a submaximal response was not a flat line, but was significantly flatter than a maximal response. Goldman et al9 found that subjects with injury also produced a curve of decreased amplitude but not as flat as submaximal effort. The shape of the curve is important- the flatter the curve the more likely submaximal effort is occurring.

RAPID EXCHANGE GRIP TEST (REG)

Hildreth et al[14]determines the maximal static grip with the Jamar dynamometer (usually position 2 or 3). The dynamometer is then alternated between hands as rapidly as possible for between 5 and 10 grips. A positive test (submaximal effort) is when the maximum rapid exchange measurement is greater than the static measurement. Joughlin et al[16] modified this test by setting the Jamar in the 3rd position and determining maximal static grip. 10-15 grips are performed at the rate of 80/min and only the maximal REG grip recorded. Joughlin found that rapid exchange grip strengths were greater than static measures in most subjects, and that submaximal efforts resulted in greater variation. 16% difference between rapid and static measure was a positive result. This test has also been performed with two Jamar dynamometers (bilateral simultaneous REG test)[16]. Hamilton-Fairfax et al[11] averaged 10 REG measures. If the average was greater than the static grip measure the test was positive (submaximal effort). This paper quoted 85% accuracy in determining maximal versus submaximal effort.

REG testing is useful where large variations occur but the literature conflicts on the definition of a positive test.

COEFFICIENT OF VARIATION (CV)

This test analyses variation across repeated grip strength measures. It is measured by dividing the standard deviation of the grip strength measurements by the mean[27]. A high CV indicates an inconsistent response from the patient, assumed to be due to submaximal effort. Matheson and Ogden-Niemeyer[18] found females had a higher variability than males, and that submaximal effort produced greater variability than genuine effort . A positive test (submaximal effort) is defined as 10% in males and 12% in females. Simonsen[29] found pain also led to variable results, and found the differentiation between pain and submaximal effort difficult. Robinson[27]used 11% to define a positive test in his series and correctly classified all maximal efforts, but only 45% submaximal efforts. The literature is equivocal on the use of CV and some researchers actively discourage its use.

FORCE-TIME CURVES

Patients sustain a maximal grip for 5 seconds and the force applied is plotted over time using computer software. A maximal effort records as a rapid initial rise sustained over 5 seconds. A submaximal effort manifests as a rapid initial rise that gradually declines over the last few seconds. Lechner et al[17] were able to accurately identify 85% of maximal efforts and 90% of submaximal efforts. This method may hold promise but requires the use of computer software and statistical knowledge. The test is time consuming and expensive and requires complex data analysis.

TEST BATTERIES

Authors refer to the use of a battery of tests to improve accuracy[26,31]. No single test detects with certainty a voluntary reduction in maximal effort.

RECOMMENDED PROTOCOL

From our reading of the literature and clinical experience we advocate the following test protocol:

1. Single maximum grip strength at Jamar position 2 (3.8cm)
2. Five Handle Position Test
4. single measurement in each dynamometer position
5. alternate hands beginning with the normal hand first
6. progress from the smallest to the widest setting (1-5)

1. Repeat single maximum grip strength after 15 second rest

RECOMMENDED ANALYSIS

1. Record the static measures taken at start and finish- the values should be within 15% of each other.
2. Compare the shape and amplitude of the graphs between hands for the 5HPT- the flatter the graph the more suggestive it is of decreased effort.

CONCLUSION

We advocate this protocol as helpful in discriminating sincerity of effort when used in conjunction with the usual clinical findings and ‘feel' for the situation. Helpful clinical findings include the following:

- History not consistent with the injury, pain or disability
- Pain which appears disproportionate to other objective findings
- Stated severe disability without accompanying muscle wasting
- Normal hand staining and wear pattern in a manual worker

This suggested protocol is fast (should take less than 2 minutes in total, and could be performed by trained staff before consultation in the office), cheap (requiring only a Jamar dynamometer and no computer software or expertise), and simple (requiring no stastical knowledge or complex calculations).

References

1. Agnew P and Maas F (1982a).Hand function related to age and sex. Archives of Physical Medicine and Rehibilitation, 63,269-271
2. Ashford R.F. ,Nagelburg S., & Adkins, R (1996). Sensitivity of the Jamar dynaometer in detecting submaximal grip effort. Journal of Hang Surgery, 21A, 402 - 405
3. Balogun, J.A., Adenola, S.A., & Akinloye, A. A. (1991a). Grip strength normative data for the Harpenden dynamometer. Journal of the Orthopaedic and Sports Physical Therapy, 14, 155-160
4. Crosby, C.A. Wehbe, M.A., & Mawr, B. (1994). Hand strength: Normative values. Journal of Hand Surgery 19A, 665-670
5. Ev Innes : Handgrip strength testing: A review of the literature Australian Occupational Therapy Journal (1999) 46, 120-140.
6. Fess, E.E. (1987). A method for checking Jamar dynamometer calibration. Journal of Hand Therapy, 1, 28-32.
7. Fess, E.E. (1995a). Documenation: Essential elements of an upper extremity assessment battery. In J.M. Hunter E.J. Mackin & A.D.Calahan (Eds). Rehabilitation of the hand: Surgery and therapy (4th edn), Vol 1, PP. 185-214). St Louis: Mosby.
8. Firrell, J.C., & Crain, G.M. (1996). Which setting of the dynamometer provides maximal grip strength? Journal of Hand Surgery, 21A, 397-401
9. Goldman, S., Cahalan, T.D., & An, K.N. (1991). The injured upper extremity and the Jamar five handle position grip test. Americal Journal of the Physical Medicine and Regabilitation, 70, 306-308
10. Hamilton, A., Balnave, R., & Adams,R. (1994). Grip strength testing reliability. Journal of Hand Therapy,7,163-170
11. Hamilton-Fairfax,A., Balnave, R., & Adams, R (1995b). Variability of grip strength during isometric contraction. Ergonomics,38,1819-1830.
12. Harkonen, R., Harju, R., & Alaranta, H (1993a). Accuracy of the Jamar dynamometer. Journal of Hand Therapy, 6,259-262.
13. Harth, A., & Vetter, W.R (1994). Grip and pinch strength among selected adult occupational groups. Occupational Therapy International, 1,13-28
14. Hildreth, D. H., Breidenbach, W. C., Lister, G. D., & Hodges, A. D. (1989). Detection of submaximal effort by use of the rapid exchange grip. Journal of Hand Surgery, 14A,742-745.
15. Janda, D.H., Geiringer, S.R., Hankin, F. M., & Barry,

D.T. (1987). Objective evaluation of grip strength. Journal of Occupational Medicine, 29,569-571.
16. Joughlin, K., Gulati, P., Mackinnon, S. E., McCabe, S., Murray, J. F., Griffiths, S., & Richards, R. (1993). An evaluation of the rapid exchange and simultaneous grip tests. Journal of Hand Surgery, 18A,245-252.
17. Lechner, D.E., Bradbury, S. F., & Bradley, L. A. (1998). Detecting sincerity of effort: A summary of methods and approaches. Physical Therapy, 78,867-888
18. Matheson, L. N., & rehabilitation Ogden-Niemeyer, L.(1987). Work capacity evaluation: Systematic approach to industrial (Revised edn). Anaheim:ERIC
19. Mathiowetz, V (1990a). Effects of three trials on grip and pinch strength measurements. Journal of Hand Therapy, 3,195-198.
20. Mathiowetz, V., Weber, K., Volland, G., & Kashman, N. (1984). Reliability and validity of grip and pinch strength evaluations. Journal of Hand Surgery, 9A,222-226
21. Mathiowetz, V., (1991). Reliability and validity of grip and pinch strength measurements. Critical Reviews in Physical and Rehabilitation Medicine, 2,201-212
22. Niebuhr, B. R., & Marion, R., & Fike, M. L. (1994). Reliability of grip strength assessment with the computerised Jamar dynanometer. Occupational Therapy Journal of Research,14,3-18
23. Niebuhr, B. R., & Marion, R. (1987). Detecting sincerity of effort when measuring grip strength. American Journal of Physical Medicine,66,16-24.
24. Petersen, P., Petrick, M., Connor, H., & Conkin, D. (1989). Grip strength and hand dominance: Challenging the 10% rule. American Journal of Occupational Therapy,43,444-447
25. Richards, L., & Palmiter-Thomas, P. (1996). Grip strength measurement: A critical review of tools, methods, and clinical utility. Critical Reviews in Physical and Rehabilitation Medicine,8,87-109.
26. Robertson, L. D., Mullinax, C.M., Brodowicz, G.R., Miller, R.A., & Swafford, A. R. (1993). The relationship between two power-grip testing devices and their utility in physical capacity evaluations. Journal of Hand Therapy,6,194-201.
27. Robinson, M. E., Geisser, M. E., Hanson, C. S., & O'Connor, P. D. (1993). Detecting submaximal efforts in grip strength testing with the coefficient of variation. Journal of Occupational Rehabilitation,3,45-50.
28. Schmidt, R. T., & Toews, J. V. (1970). Grip strength as measured by the Jamar dynamometer. Archives of Physical Medicine and Rehabilitation,51,321-327.
29. Simonsen, J. C. (1995). Coefficient of variation as a measure of subject effort. Archives of Physical Medicine and Rehabilitation,76,516-520.
30. Smith, R. O., & Benge, M. W. (1985). Pinch and grasp strength: Standardisation of terminology and protocol. American Journal of Occupational Therapy, 39,531-535.
31. Stokes, H.m., Landrieu, K. W., Domangue, B., & Kunen, S. (1995). Identification of low-effort patients through dynamometry. Journal of Hand Surgery. 20A,1047-1056
32. Trossman, P. B., & Li, P. W. (1989). The effect of the duration of intertrial rest periods on isometric grip strength performance in young adults. Occupational Therapy Journal of Research,9,362-378.

Author Information

L. Andrew Ashton
Prince of Wales Hospital

Stuart Myers
Prince of Wales Hospital