



Towards a comprehensive Functional Capacity Evaluation for hand function

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ABSTRACT

The aim of this study was to develop a more efficient (i.e. shortened) protocol for hand function capacity evaluation and to test the agreement of the protocol compared to the original protocol. 643 Healthy subjects performed tests for hand function. Agreement between two shortened protocols was compared with an existing protocol. The original protocol was performed once and the proposed shortened protocol differed in the number of trials which were reduced by statistical elimination. Agreement was determined with Intraclass Correlation Coefficients (ICC) and Limits of Agreement (LoA). Excellent ICCs (≥ 0.91) were observed in all proposed protocols except for the one trial purdue pegboard test protocol. For all tests of hand function, shorter protocols are valid to determine hand function. For Tip Pinch Strength testing, Palmar Pinch Strength testing and the Purdue Pegboard test, a two-trial protocol is recommended, because the LoA were considerable, which could affect decision-making with regards to hand capacity. For the Hand Grip strength test, the Key Pinch Strength test and the Complete Minnesota Dexterity Test, a one-trial protocol is recommended, because the LoA were acceptable. It was concluded that for healthy subjects, this shorter protocol is a reliable measure. Further testing of the short form hand FCE protocols should be completed on patients with disabling conditions prior to widespread use of these protocols among clinical samples.

1. Introduction

The evaluation of hand function is of importance in the assessment of upper limb impairments such as complaints of arm, neck and shoulder (CANS), chronic musculoskeletal pain or disabilities as the result of rheumatoid arthritis, chronic fatigue syndrome, developmental disabilities, muscular dystrophy, chronic pain or stroke (Blair et al., 1987; Mitsionis et al., 2009). Due to the importance of hand force in relation to work-related musculoskeletal disorders, evaluation of hand function and work ability has been a research issue among ergonomics researcher (Bao and Silverstein, 2005).

Upper extremity work capacity testing can be a part of Functional Capacity Evaluations (FCEs). FCEs are standardized batteries

of tests which all together form an evaluation of the functional capacity of work-related activities (Soer et al., 2008). FCEs can be job specific (Innes, 1999) or pathology specific (Reneman et al., 2005; Gross et al., 2006; Gouttebauge et al., 2010) and they can be used to determine hand function (Reneman et al., 2005; Soer et al., 2006). A pathology specific FCE protocol for patients with work related upper limb disorders, consists of tests which determine Hand Grip strength, finger strength and upper limb dexterity (Soer et al., 2006). Usually these tests consist of multiple repeated trials, but there is discussion about the efficiency and validity (Watanabe et al., 2005), because repeated trials are time consuming, expensive and results may be affected by (muscle) fatigue (Watanabe et al., 2005; Reddon et al., 1985) and/or learning (Watanabe et al., 2005). Reliable and validated FCE protocols that consist of fewer or single trials to assess hand function have not been described. Some authors argue that a more efficient protocol can be developed since protocols that consists of less trials do not seem to affect the validity and reliability of the protocol (Soer et al., 2006; Coldham et al., 2006; Roberts et al., 2011).

Hand and finger grip strength testing is used to quantify physical exposures of work activities to guide prevention efforts in the

Abbreviations: FCE, Functional Capacity Evaluation; ASHT, American Association of Hand Therapists; LoA, Limits of Agreement; SDD, Smallest Detectable Difference; ICC, Intraclass Correlation Coefficients.

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management of work-related musculoskeletal disorders. Many exposures are difficult to collect in the work environment; therefore grip strength testing in combination with methods such as “force matching” is used by ergonomist in the field. (Bao and Silverstein, 2005; Dale et al., 2011; Wiktorin et al., 1996). It is also being argued that a measure of grip strength is not a true measure of grip strength alone because of the influence of pain and therefore a shorter protocol could lead to a more true measure of Hand Grip strength (Coldham et al., 2006). A less time consuming and demanding protocol could lead to reliable outcomes but that are less physical demanding, for workers with and without history of upper limb pathology (Coldham et al., 2006; Roberts et al., 2011). Therefore, a more efficient FCE protocol which consists of fewer trials may also lead to a more valid and reliable evaluation of hand function. Shorter protocols are more beneficial for ergonomists and occupational health specialists who determine hand function for work ability assessments, because it leads to a less time intensive and more cost efficient procedure (Dale et al., 2011). The aim of this study was to develop a more effective, lean and valid protocol to assess hand function. It was hypothesized that a shorter protocol does not affect the validity of hand function capacity testing.

2. Methods

2.1. Subjects

643 Healthy working subjects, 402 men and 241 women, between 20 and 61 years of age and working in more than 180 different occupations participated in this study. Inclusion criteria were meeting the criteria of the Physical Activity Readiness Questionnaire (Shephard, 1988; Thomas et al., 1992), a resting systolic and diastolic blood pressure of less than 159 mmHg and 100 mmHg (Matheson et al., 1995) and working at least 20 h a week with no absenteeism from work because of musculoskeletal complaints for more than 2 weeks during one year prior to the FCE. All patients signed informed consent.

2.2. Procedures

Prior to the FCE, participants filled out a set of questionnaires concerning general demographics, self-reported health, and self-reported habitual physical activity. General demographics included sex, age, weight, height, education level, and work status. Self reported health was assessed by means of the RAND-36 Health Survey, a generic health measuring scale covering 9 domains of functioning and well-being (Hays et al., 1993). These domains were vitality, mental health, social functioning, general health perception, pain, role limitations (emotional problem), role limitations (physical problem), physical functioning and health change (Hays et al., 1993). On completion of the FCE, subjects received their personal results, a coupon of €15 and travel expenses. The study was approved by the Medical Ethical Committee of the University Medical Center Groningen.

The existing protocol consisted of six tests which measured elements of hand function. These tests were derived from the WorkWell FCE (WorkWell Systems, 2006). These tests were the Handgrip strength test, Tip Pinch Strength, Palmar Pinch Strength, Key Pinch Strength, Purdue Pegboard Test and the Complete Minnesota Dexterity Test. All tests were conducted for the right and the left hand. The shortened protocols were not tested separately, but were derived from the data of the criterion protocol. The one trial protocol is based on the first trial of the criterion protocol, whereas the two trial protocol is based on the results of the first two trials as performed in the criterion protocol. Subjects were individually evaluated by 1 of 15 physical therapy students who had completed

a 2-day FCE training by a licensed WorkWell trainer specifically for this purpose. Inter-rater reliability of the tests of the WorkWell FCE were excellent with ICCs of 0.95–0.98 (Gross and Battié, 2002). The data of the tests were derived from subjects who performed a larger FCE protocol which is described in the study by Soer et al. (2009).

2.3. Protocols

2.3.1. Protocols for hand function

Several proposed shortened protocols were studied by testing the agreement between both protocols. The shortened protocols were compared to an existing original protocol which was considered to be the criterion protocol with good psychometric properties (Innes and Straker, 1999). The original tests from the WorkWell FCE determine hand function by the means of six valid and reliable tests (Laffayette Instruments, 1999; Soer et al., 2006; Mathiowetz et al., 1984; Mathiowetz, 2002; Desrosiers et al., 1997). The shortened protocols for the Hand Grip strength, finger strength tests and dexterity tests consisted of either one or two trial(s). The numbers of trials of the proposed protocols are described in Table 1.

2.3.2. Criterion protocol

2.3.2.1. Handgrip strength. Isometric grip strength was determined by the use of a hand dynamometer (Jamar PC 5030). The Jamar dynamometer gives the most accurate and acceptable measures of hand strength (Mathiowetz et al., 1984; Mathiowetz, 2002). The subjects performed the protocol in a seated position, the subjects held their shoulder adducted and neutrally rotated, elbow flexed at approximately 90°, and the forearm and wrist in neutral position (Innes, 1999; Mathiowetz et al., 1985a, 1985b). Grip strength of the right and left hand was measured in a 3-trial procedure as recommended by the American Society of Hand Therapists (ASHT) (Garner, 1992). The average amount of kilogram-force was scored. Test-retest reliability in healthy subjects is high by the use of this protocol and materials (ICC = 0.93) (Innes and Straker, 1999).

2.3.2.2. Finger strength. The finger strength was measured with Isometric Tip, Key, and Palmar Pinch Strength. A Pinch-Grip dynamometer (Preston Pinch Gauge) was used to determine finger strength. The subjects performed the protocol in a seated position, the subjects held their shoulder adducted and neutrally rotated, elbow flexed at approximately 90°, the forearm and wrist in neutral position (Innes, 1999; Mathiowetz et al., 1985a). For the tip pinch, subjects pinched for 3 s with index finger above thumb. Facilitation of middle finger was not permitted. Palmar strength was measured with both index and middle finger on top and thumb below the dynamometer. Key strength was measured using pinch strength of thumb on top. Strength of the right and left fingers were measured in a 3-trial procedure. Average kilogram-force was scored. Test-retest reliability in healthy subjects is high (ICC = 0.76) (Soer et al., 2006).

Table 1
Number of trials per test of the protocols.

Tests	Criterion protocol	Proposed protocol (1)	Proposed protocol (2)
Hand Grip Strength	Mean of 3 trials	Mean of 2 trials	Score of 1 trial
Tip Pinch Strength	Mean of 3 trials	Mean of 2 trials	Score of 1 trial
Key Pinch strength	Mean of 3 trials	Mean of 2 trials	Score of 1 trial
Palmar Pinch Strength	Mean of 3 trials	Mean of 2 trials	Score of 1 trial
Purdue Pegboard Test	Mean of 3 trials	Mean of 2 trials	Score of 1 trial
Complete Minnesota Dexterity Test	Mean of 4 trials	Mean of 2 trials	Score of 1 trial

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