J Shoulder Elbow Surg (2014) 23, 1806-1812

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Reliability and agreement between 2 strength devices used in the newly modified and standardized Constant score

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Hypothesis: The new and standardized test protocol for the Constant score (CS) provides new methodology, but different devices are still used for shoulder strength testing. It was hypothesized that strength measurements using the IsoForceControl (IFC) dynamometer (MDS Medical Device Solutions, Oberburg, Switzerland) would provide results comparable with the IDO isometer (Innovative Design Orthopaedics, Redditch, UK).
Materials and methods: Sixty healthy subjects, aged 19 to 83 years, were studied, with 5 men and 5 women in each of 6 ten-year age groups. The IFC and IDO were used in randomized order with an 8-minute interval between testing. Subjects performed 3 successive trials with strong verbal encouragement, with 1 minute between trials. The best strength performance was used in the analysis. The rater and subjects were blinded to all results.
Results: The IFC produced 0.28-kg (0.62-lb) higher strength values on average than the IDO ($P = .002$). The intraclass correlation coefficient ($ICC_{2,1}$) was 0.97 (95% confidence interval, 0.95-0.98), whereas the standard error of measurement and smallest real difference were 0.43 kg (0.95 lb) and 1.2 kg (2.63 lb), respectively. The total CS and strength reached mean values of 92.4 points (SD, 6.2 points) and 8.2 kg (SD, 2.6 kg) (18.0 lb [SD, 5.8 lb]), respectively, and were negatively associated with age ($r > -0.407$, $P \leq .001$). The strength values decreased ($P \leq .001$) by 1.3 CS points per decade, and women had strength values that were 8 CS points lower on average than those of men of the same age.
Conclusions: The relative (intraclass correlation coefficient) and absolute (standard error of measurement) reliability between the IFC and IDO is excellent, indicating that performances reported from settings using the IDO are comparable with those recorded with the IFC in other settings.
Level of evidence: Basic Science, Kinesiology.

Keywords: Shoulder; Constant score; standardization; strength devices; intrarater reliability; agreement

Institutional review board or ethical committee approval: not applicable.

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1058-2746/$ - see front matter © 2014 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2014.04.011

The Constant score (CS)[10] is extensively used to evaluate outcome for patients with various shoulder disorders.[17,20,21,26,28] Correspondingly, a large number of studies have examined or reviewed the psychometric properties of the CS (0-100 points) or parts of the score, for example, the shoulder strength part (0-25 points).[1,3,6-8,14-16,19,22-25,27,29] Various test protocols have routinely been used at different centers, probably because of authors' own interpretation of Constant's original work but also because of a lack of an internationally accepted and standardized test protocol. Constant et al[9] published a new guideline report in 2008 to solve some of the methodology problems associated with the CS, but still without including a standardized test protocol. A standardized CS test protocol in Danish and English was provided in 2013,[2] based on this new guideline report and the original article by Constant and Murley.[9,10] However, this protocol has not been validated, which is a requisite if it is to be recommended for use in daily clinical practice. The standardized protocol provides a thorough description of the CS including the assessment method of maximum shoulder strength (part D of the CS)[2] but does not recommend use of a specific strength device. Strength devices differ, ranging from an unsecured mechanical spring balance to several digital devices that differ greatly in cost. The Isobex dynamometer and the IsoForceControl (IFC) dynamometer (both devices from MDS Medical Device Solutions, Oberburg, Switzerland) have been used in several previous studies and are, by many investigators, considered the gold standard.[1,6,14-16,18,23,27] However, the IFC is expensive (approximately €1,600), which limits many centers from acquiring it. Several newer and cheaper devices designed specifically for the CS strength component are now available. One of these is the IDO isometer (Innovative Design Orthopaedics, Redditch, UK), a transportable digital dynamometer, costing approximately €350, that is designed for the CS strength component. Whether the results of strength assessment using the low-budget IDO are comparable with the results of the expensive IFC is unknown.

The primary aim of this study was to test the hypothesis that the relative reliability between strength measures using the IFC and IDO is excellent and that measurement error (absolute reliability) is low when using the newly standardized CS test protocol.[2] The secondary aim was to examine whether the total CS and the strength part (part D) are related to age and sex in healthy subjects.

Material and methods

Sixty adult volunteers (30 women and 30 men, aged 19-83 years) from the Copenhagen area were tested within a 2-week period. The following inclusion criteria were used: age 18 years or older, ability to give informed consent, ability to speak and understand Danish, and no current shoulder problems. Subjects were recruited by telephone or E-mail, according to 6 prespecified age groups, with 10 subjects (5 women and 5 men) in each of the following 6 age groups: 18 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years, 60 to 69 years, and 70 to 90 years.[15] All subjects received written and oral information about the project and signed an informed consent form before they were tested.

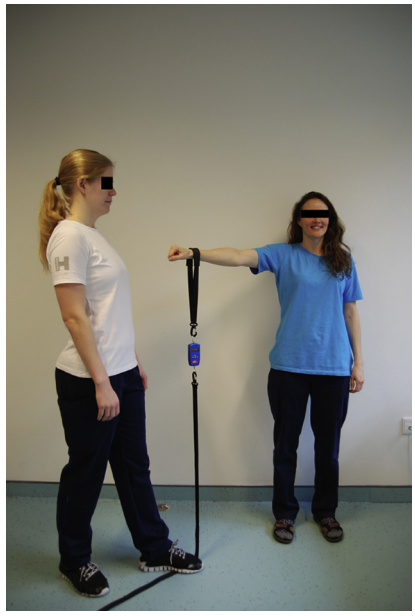

Figure 1 IDO isometer strength device.

Strength devices

The IDO isometer is a transportable, digital CE-registered dynamometer designed to measure the average isometric muscle strength in kilograms or pounds over a period of 3 seconds (Fig. 1).

The IFC is a transportable, digital CE-registered dynamometer that registers strength values in newtons at the start and end of a self-selected preset period between 5 and 20 seconds, as well as maximum and average strength values (Fig. 2). The peak force produced over the period from 2 to 4 seconds in a 5-second period was used in our analysis. Values in newtons were converted to kilograms by dividing by 9.82, as 1 Newton equals 9.82 kg.

Procedures

All test procedures and instructions were standardized according to the newly published CS test protocol.[2] The 2 strength devices are self-calibrating when started, but the agreement between devices was examined with a 5- and 10-kg weight load. The best of 3 recordings for each device showed a difference between devices of 0.02 kg and 0.04 kg. Pilot testing of the protocol and all procedures was performed in 10 subjects not included in the project. Two senior physiotherapy students were used as test raters. The first rater, who instructed all test subjects on the objective parts of the CS (parts C and D) including strength assessment, was blinded to all measurements and kept unaware of the results until all subjects had been tested. The second rater noted the results during testing and ensured that all subjects completed the subjective parts of the CS (parts A and B). Both raters were within 6 months of graduation, and the role of physiotherapy students as raters corresponds with a previous study with a focus similar to the present study.[14]