Comparison of shoulder strength assessment in scaption with an isometric dynamometer and a weighing machine: a pilot study

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A R T I C L E   I N F O

Keywords:
Shoulder
Strength assessment
Dynamometer
Weighing machine
Spring balance
Constant score

Level of evidence: Level III, Diagnostic Study

Background: Strength testing is an important aspect of shoulder examination. To date, strength assessment has many limitations. There is no single standard instrument for measuring, and various current devices have problems in reliability, accuracy, and cost. This study compared the results of an innovative and simple method of strength testing (weighing machine) with an existing method (isometric dynamometer).

Methods: Shoulder strength was tested in 80 individuals, 60 with normal shoulders (group 1) and 20 with shoulder pathology (group 2). Strength was tested in the standard position of 90° of elevation in the scapular plane (scaption) with the elbow extended and forearm pronated while resistance was applied just proximal to the wrist. A weighing machine and an isometric dynamometer were used for strength testing.

Results: There was a mean difference of 0.26 kg in group 1 (95% confidence interval [CI], 0.16-0.36; \( P < .0001 \)) and 0.30 kg in group 2 (95% CI, 0.04-0.72; \( P = .0291 \)) between the weighing machine and the isometric dynamometer. Although statistically significant, these differences were not clinically significant.

Conclusions: This pilot study shows that strength assessment by an innovative and simpler technique with a weighing machine gives similar results as an isometric dynamometer.

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Strength testing is performed to assess a patient’s ability to maintain maximum voluntary muscle tension against a force or resistance. Evaluating muscle strength is an essential component of the physical examination of the shoulder and is used for diagnosis, monitoring treatment progress, and disability evaluation. Although testing of shoulder strength is routine, accurately quantifying shoulder strength can be challenging. Strength testing can be subjective or objective. Subjectively, muscle strength may be manually tested and graded on a scale of 0 to 5. However, such subjective assessment is limited by the lack of intrarater and inter-rater reliability and cannot be expressed in standard units.

Several methods of objectively quantifying muscle strength have been proposed, including the isometric dynamometer, spring balance, and cable tensiometer. These methods have been particularly applied to the clinical research setting as a component of functional outcome scores. For instance, in the Constant score, which was adopted by the European Society for Surgery of Shoulder and Elbow as the primary functional outcome score for clinical research, 25% of the score is apportioned to strength assessment. In the original description, the strength assessment portion of the Constant score was performed with a spring balance or cable tensiometer. However, studies have questioned the reliability of the spring balance. More recently, Gerber and Arneberg developed an isometric dynamometer and defined a range of normal values for strength in scaption measured at the wrist. Various studies have proved the efficacy of such instrument of measure, particularly during calculation of a Constant score. However, this device is expensive and not readily available in all centers.

The primary author (P.C.) has developed a simple method of assessing shoulder scaption strength with the use of a weighing scale.
The torso was not stabilized.

Table II

| Variable     | Group 1 (n = 60) | Group 2 (n = 20) | P value |
|--------------|------------------|------------------|---------|
| Male sex     | 61.6             | 50.0             | .092*   |
| Age, yr      | 37.6 ± 12        | 49.2 ± 10        | <.001*  |
| Height, m    | 1.72 ± 0.10      | 1.68 ± 0.09      | .333*   |
| Weight, kg   | 70 ± 12          | 70 ± 12          | .395*   |

Categoric data are shown as the percentage and continuous data as mean ± standard deviation.

* Wilcoxon test.
a maximum of 100, is divided into 4 subscales, including pain, activities of daily living, range of motion, and strength. The latter represents 25% of the score (25 points maximum). The University of California, Los Angeles Shoulder Rating Scale includes the factor of strength as well as pain, motion, function, and patient satisfaction in its assessment.\(^5\) In these scores, a major source of error is the measurement of strength.\(^8\)

The subjective assessment by manual muscle testing was first introduced by Lovett and Martin.\(^9\) To objectively quantify muscle strength, the handheld dynamometer was introduced. These devices had certain limitations, such as upper limit of recording muscle force and difficulty in maintaining the device perpendicular to the limb.\(^2,5\)

Later, Hislop and Perrine\(^15\) introduced the first isokinetic device, followed by several other isokinetic devices. These devices were not portable, required elaborated setups and stabilization procedures, and were not suitable for clinic setups.\(^20\)

The data of the present study show encouraging similar results in scaption strength between an isometric dynamometer and our new method, which uses a weighing scale. The presented method with a weight machine meets the required standard\(^3\) because it is reproducible and is easy and quick to use in a clinical or research setting without the need for sophisticated equipment. The isometric dynamometer remains a validated alternative, but in comparison, there is a price difference in favor of the former.

The major limitation of this study is lack of an intrarater and inter-rater reliability analysis. However, the goal of this prospective pilot study was simply to perform a comparison to current validated methods in asymptomatic individuals and in those with documented shoulder pathology. Further study is needed, including a reliability analysis and examination of the weighing scale methods in a larger population with different shoulder pathologies and in different shoulder positions.

**Conclusion**

This pilot study shows that strength assessment by an innovative and simpler technique with a weighing machine gives similar results as an isometric dynamometer. Further studies are warranted to confirm the reliability of this new method.

**Disclaimer**

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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