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Original Research Article

Normative Data and Intra - Rater Reliability of Scapula - Humeral Muscle Strength Using Push - Pull Hydraulic Type Hand Held Dynamometer in Healthy College Students

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ABSTRACT

Objective: To establish normative clinical data for Scapula-humeral muscle strength of men and women, ages 18-24 years, using a Push-Pull hydraulic type hand held Dynamometer (500 lb) and to find the intra-rater reliability of this device too.
Design: The study collected objective 5Scapula-humeral muscle strength data for 40 healthy boys and girls using the Push-Pull hydraulic type hand held Dynamometer (500 lb).
Setting: The study was conducted in Out-Patient Physiotherapy department, MSAJ College of Physiotherapy.
Subjects: 40 normal volunteers (14 boys and 26 girls).
Methods: 5 muscle groups of Scapula-humeral muscles were tested using standardized methodology.
Main Outcome Measurements: Data were recorded by the Single Physiotherapist for each muscle group in each subject twice session in same day.
Results: This study presents data from 40 healthy, normal subjects, unequally divided by gender and age. Means standard deviations were determined for each group and further categorized by age, gender, and hand dominance. These data confirm some expected patterns: In all the muscle group's boys have significantly higher strength than girls, and the dominant side is stronger than the non-dominant side in both genders. Relative values for various muscle groups are analysed and presented. Intra-rater reliability of dynamometer was checked with Cronbach's Alpha based formula and the intra-rater reliability of dynamometer were highly significant on all 5 scapula-humeral muscles (Reliability value is 0-1, highly significant).
Conclusions: This study provides an initial normative database across in healthy college students for scapula-humeral muscle strength for monitoring clinical care and research for injured and impaired patients. These data are an essential and initial step toward comprehensive normative databases for upper extremity objective ordinal strength measurements with the Push- Pull hydraulic type Hand held Dynamometer (500 lb) and having a high reliability of using this device in this study. Even this device can be utilized further in subjects with muscle dysfunction.

Key words: Normative clinical data, Intra-rater reliability, Push-Pull dynamometer, scapula-humeral muscle strength, healthy subjects.

INTRODUCTION

Muscle strength is the most important predictor of function, mobility, independence, and activities of daily living. Assessment of muscle strength in clinical settings is usually quantified by manual muscle testing. [1] Different systems and scales have been developed over the decades like modified Kendall systems (variously called the Medical Research

Council Scale or Oxford Scale). [2] In This system facilitates quick clinical assessments and description of muscle strength in upper and lower extremities (descriptive evaluations).

During the past 3 decades, many research-based and commercial analog, digital, and mechanical quantitative instruments have been developed to provide such objective, ordinal data, such as Cybex Isokinetic Dynamometer (Cybex International, Medway, MA); Biodex (Biodex Medical Systems, Shirley, NY); and Isostation (Isotechnologies, Hillsborough, NC). [3] These instruments can record forces produced by concentric, eccentric, isokinetic, and isometric muscle contractions. They are highly sensitive, reproducible, and contribute valuable data. However, they are typically limited to research settings and large institutions. They are cumbersome, time consuming, expensive, and lack portability. They can measure only a few limited muscle groups. Few have proved to be practical in busy clinical practices.

More recently, handheld, portable, quantitative instruments have been introduced. These instruments include the Nicholas Manual Muscle Tester (NMMT; Lafayette Instrument, Lafayette, IN) and the MicroFet 2 (Hoggan Health Instruments, West Jordan, UT), Push-Pull hand held Dynamometer. [4] They are relatively inexpensive, simple to use, and practical for busy clinical settings. They still have drawbacks, however, particularly an absence of large sample normative isometric data with age and gender subsets and available normative data for only limited numbers of upper extremity muscle groups. [5]

This study was designed to provide an initial database of dominant and non-dominant values for 40 Scapula- humeral muscle groups in healthy college students aged 18-24years for one such device, the Push- Pull hydraulic type hand held Dynamometer (500 lb) and to find intra-rater reliability of this device also.

METHODOLOGY

This study includes 5 major muscle groups in each upper extremity (see Table - 1), Kendall and Kendall MMT testing parameters (break test), [6] 40 healthy subjects (14 boys and 26 girls), and ages of subjects ranging from 18-24 years.

Subjects

The study included 40 healthy volunteers, 14 boys and 26 girls, aged 18-24 years old. Subjects were randomly recruited from college students of varying age between 18-24 years old. All subjects who provided consent were free of cardiovascular, neurologic, and musculoskeletal disease and free of any upper extremity impairments. Each subject completed informed consent form, and biometric data including age, gender, height, weight, and hand dominance. Ambidextrous subjects were excluded.

Procedure

Five major Scapula-humeral muscle groups were tested bilaterally with the Push-Pull hydraulic type hand held Dynamometer (500 lb). External and Internal rotators of Shoulder joint measurements were made in a high sitting position. During testing the subjects were seated with proper body alignment on a standard height couch with towel roll under the axilla, and with both feet placed flat on the foot stool. Middle and lower trapezius were measured in prone position with towel under the forehead. Serratus anterior was measured in supine position and measured using modified Kendall position. Published methodology known as the “break test” was used for the testing procedures. [7] The subject applies a maximal force that is resisted by the examiner. The “breaking force” is the amount of force required to overcome a maximal effort muscle contraction in order to move the limb from the initial starting position. Two non-resistive training trials were provided for each muscle group to demonstrate to the subjects the positions and specific muscle group contraction that would have the resistance applied. Three measurements of each muscle group were

recorded using this technique. To ensure maximal isometric strength and to minimize muscle fatigue, the evaluator performed each test by alternating right and left sides. The evaluator stopped any measurement if there was evidence of fatigue, the subject was attempting to compensate with another muscle groups, the subject changed body posture, or the subject was no longer able to maintain the isometric contraction. [8]

The testing sequence follows from external rotation and internal rotation of shoulder, middle and lower trapezius and finally serratus anterior and starting with the dominant side. Thus 5 muscle groups were recorded for each subject. All testing was performed by one experienced registered Physiotherapist (10 years in academic as well as clinical practice) who had 1 year of training and experience using this Push-Pull hydraulic type Dynamometer (500 lb). After 2 hours of rest period again the measurement were made as same above method.

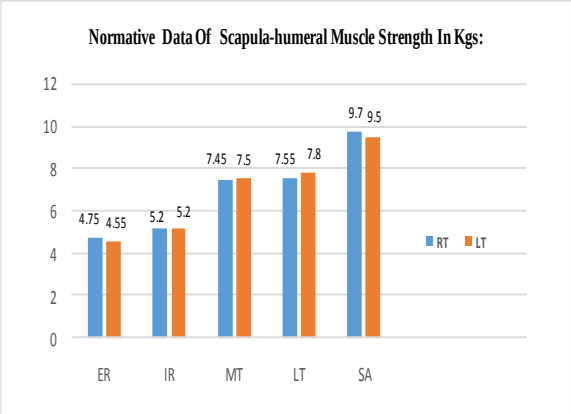
RESULTS

For this study, 1200 measurements were recorded. This number represents 6recordings for each of the 5muscle groups, in 40 subjects, for either gender, and for each side (dominant versus non-dominant). Data were collected from both session of 5 scapula-humeral muscle groups and analysed with mean and standard deviation. Intra-rater reliability of dynamometer was checked with Cronbach's Alpha based formula and the intra-rater reliability of dynamometer were highly significant on all 5 scapula-humeral muscles (Reliability value is 0-1, highly significant).

Table1: Normative Data For Scapula-Humeral Muscle Strength In Kgs

Measurement values:	External rotators:		Internal rotators:		Middle trapezius:		Lower trapezius:		Serratus anterior:	
	Rt side:	Lt. side:	Rt side:	Lt. side:	Rt side:	Lt. side:	Rt side:	Lt. side:	Rt side:	Lt. side:
1.	4.7	4.5	5.3	5.2	7.4	7.5	7.5	7.8	9.6	9.5
2.	4.8	4.6	5.0	5.2	7.5	7.5	7.6	7.8	9.8	9.5
Mean values	4.75	4.55	5.2	5.2	7.45	7.5	7.55	7.8	9.7	9.5
Cronbach's Alpha	0.985	0.991	0.992	0.996	0.985	0.987	0.986	0.994	0.979	0.994

Normative clinical data of scapula - humeral muscle strength of healthy subjects:



DISCUSSION

Our results indicate that intra-rater reliability of strength measurement of the shoulder and scapular muscles using push pull dynamometer has excellent reliability in healthy subjects. Several studies have reported the reliability of HHD when assessing muscle strength of the upper extremity; however, they often highlight the fact that reliability decreases because the individual applying the test is unable to stabilize the patient. Lu et al demonstrated adequate stabilization of the HDD when evaluating the knee flexors and extensors and obtained reliable results. [9] Insufficient examiner strength can cause poor intra-rater reliability with the HHD. [10] In this study, we found that moderate build subjects had greater muscle strength, and in these patients the break test will be stabilised properly by the therapist to get reliability. This indicates that the higher subject BMI and lower tester strength can negatively affect reliability.

The important issue is the number of times the HDD application should be repeated in 1 session. There are various applications reported in the literature; some studies accept the highest value obtained,

while others calculate the mean of values obtained from repeated tests. [11-13] We think that average strength scores showed a better correlation with motor performance than maximal strength scores. This was confirmed by Morris et al, who reported that no more than 3 tests should be carried out. [14] When evaluating the reliability between tests we discovered that they were very similar. This led us to believe that repeating the test a third time may be unnecessary. While assessing the results obtained from the third test, we observed that mean muscle strength was lower than those obtained from the first and second tests. This situation can be interpreted as muscle fatigue or a decrease in motivation of the healthy subjects. [15] For this reason, we think that reliable results can be obtained when the test is repeated fewer times, while reducing errors to a minimum. Another important thing we had noticed during the study is compensatory movement done by subjects during the measurement. These compensatory movements also can cause poor intra-rater reliability with HHD, which should be corrected with proper prior demonstration and stabilisation of proximal joints.

CONCLUSIONS

This study provides an initial normative database across in healthy college students for scapula-humeral muscle strength for monitoring clinical care and research for injured and impaired patients. These data are an essential and initial step toward comprehensive normative databases for upper extremity objective ordinal strength measurements with the Push- Pull hydraulic type Hand held Dynamometer (500 lb) and having a high reliability of using this device in this study. Even this device can be utilized further in subjects with muscle dysfunction.

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