Dynamometer Testing of Upper Trapezius Muscle Strength

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This investigation was undertaken to establish the normal data of 73 young males and females for upper trapezius muscle strength. Three-second static strengths of right upper trapezius by simultaneously shrugging both shoulders were measured using an electric musculator, after which the numerical index of the maximal strength and the 3-second process of the strength were printed out. A one-way analysis of variance for repeated measures revealed no significant differences in the male and female groups ranging in age from 18 to 20. The umpaired t test between males and females differed significantly at the 1% level, while the same test between the same age groups of the two sexes was found significantly different ($p<0.01$) only at the 19-year-old group. Our results confirm the common expectation of greater strength for men than for women in upper trapezius. The result suggests that our data provide a means of comparing a patient's scores with normal individuals of the same sex and age.

Key Words
Dynamometer,
Upper trapezius,
Muscle strength,
Scapular elevation,
Young males and females.

INTRODUCTION

The authors have focussed on voluntary scapular elevation in the procedure of the restoration of hemiplegic upper extremity, which resulted in a product of a modified goniometer as well as "Shrugging Movement Test (SMOT)" (1-4). With the goniometer, SMOT was conducted on elderly stroke patients with hemiplegia categorized according to Brunnstrom's motor recovery stage (5) and healthy elders, which revealed statistically significant difference between the two groups and among the stages (1-4). The upper trapezius is the principal initiator of force couple (serratus anterior and lower trapezius) (6). Therefore strengthening the upper trapezius is of prime importance in stroke patients with hemiplegia. Manual muscle testing is a very important clinical tool used by physical and occupational therapists to determine a patient's muscle strength (7, 8). Reliable and valid evaluation of manual muscle strength is of great importance in determining the effectiveness of various physical and occupational therapy procedures. Therefore the collection of reliable and valid evaluation data depends upon the use of accurate test instruments that have standardized procedures for their administration.

Several investigators used the hand-held dynamometers for muscle strength (9-18). Although manual muscle testing is a reliable procedure and can be used to predict specific or general function, the measurements of manual muscle testing can be much limited in making precise difference among individual muscle strengths, especially with numerical indexes (19). Even with the hand-held dynamometers necessity to hold a dynamo-

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meters with hands and continue to push it against the muscle strength concerned could prevent us from measuring the precise the strength.

If the strength measurements used by clinicians are to be relevant to practice, they must fulfil at least four criteria (20): 1) they must be sensitive enough to distinguish subnormal from normal muscle strength; 2) they should be precise enough to document both increases and decreases in strength; 3) they should be reliable. The best way to measure muscle strength is to utilize a musculator to the muscles concerned.

Normative data are needed to interpret precise evaluation data with musculator to set realistic treatment goals. No norms on scapular elevation strength with dynamometry or instrument that are based on the standardized procedure have previously been reported. Therefore the purpose of this study was to establish normative data for healthy subjects aged 18 to 20 years for scapular elevation strength evaluations based on standardized procedures and instructions (Figure 1).

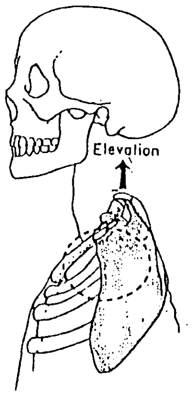

Figure 1. Scapular elevation (21)

METHOD

Subjects

Subjects were 73 healthy young college students, all of whom provided informed consent. The mean age of 18 male and 55 female students had 19.1 ± 0.5 (range, 18 to 20 years) and 18.8 ± 0.7 (range, 18 to 20 years), respectively (Table 1). All subjects were free from disease or injury that would affect their upper trapezius strength. None of them exhibited any postural abnormalities. Moreover, no subject was any athlete who trained scapular elevation strength. All could follow instructions.

Table 1. Summary of musculator test scores of healthy subjects

Sex	N	Age	Muscle Strength(kg)
Male	18	19.1±0.5	86.0±22.6
Female	55	18.8±0.7	45.8±10.9

Mean ± SD

Procedure

Each participant was seated in a straight backed testing chair with another fixed arm perpendicular to the arm rest, on which a padded force plate of the musculator (OG Giken, GT-30) was installed. The legs of the testing chair was set high enough for every student not to touch his feet on the floor to prevent his buttocks from rising off the chair by pushing the feet against the floor. The participant kept sitting with his arms dangling outside the chair. The force plate was placed against the superior aspect of the tested shoulder girdle, just distal to the acromioclavicular joint. The force plate of the musculator always was placed perpendicular to the limb segment toward which it was directed, and the plate always was set in the same position on the tested limb (Figure 2).

The musculator test consisted of isometric "make contractions" in which the subjects used upper trapezius, after the tester demonstrated to the subjects the muscle contraction to be performed and they were instructed "Shrug your shoulders", to make a maximal shoulder elevation effort ("make" a test) of 3 seconds (Figure 3). This trial was repeated twice. A 3-minute rest was taken between the tests to obtain the subject's basal heart rate. In the display of the controller the maximal muscle strength (kilograms) in the test was presented, while the 3-minute process of the strength from the beginning to the end was printed out in the printer for musclator (OG Giken, GT-100P).

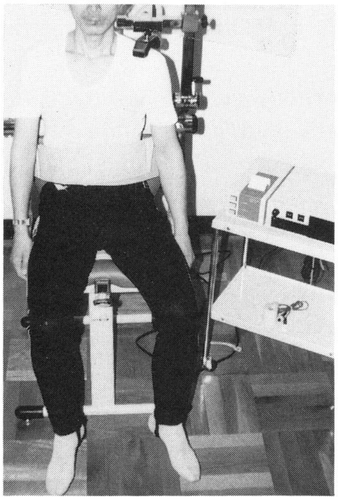

Figure 2. Starting test position in which a subject kept sitting with his arms dangling outside the chair without touching his feet on the floor.

Figure 3. Scapular elevation for 3 seconds. The force plate of the musculator was always placed perpendicular to the limb segment toward which it was directed.

RESULTS

The first table summarizes the musculator test scores of the subjects. For these subjects the mean scores of males and females showed 86 ± 22.6 kg (±SD) and 45.8 ± 10.9 kg (±SD), respectively. The males' scores were higher than the females' (Table 1). A significant difference was found between 19-year-old male and female with the 1% level.

As shown in Table 2, the mean scores of muscle strength both in males and in females increased from 18 to 20 years old (Figure 4). However, a one-way analysis of variance (ANOVA) for repeated measures among the three age groups in the same sex found no statistically significant difference.

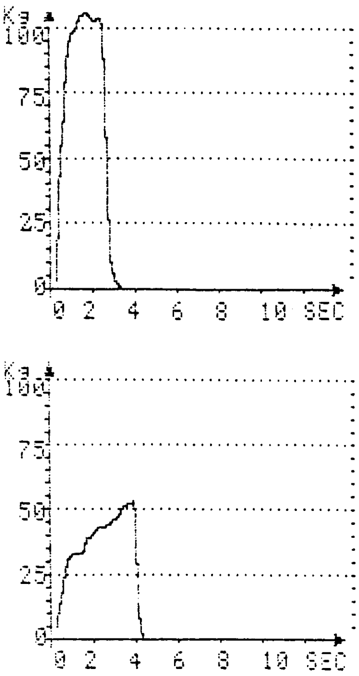

Figure 4. Comparison of upper trapezius strength between male (upper) and female (below). It is characteristic that male's power reached the peak with faster velocity than female's, while females obtained the peak of power a few times during the 3-second muscle strength testing.

Table 2. Summary of musculator test scores in relation to age and sex

	Age	N	Muscle Strength(kg)
Male	18	2	65.5±30.4
	19	13	87.7±17.4
	20	3	93.7±39.1
Female	18	20	42.6±12.6
	19	28	46.9± 9.2**
	20	7	50.9±10.6

Mean ± SD
**p<0.01

DISCUSSION

The role of the upper trapezius is maintaining the scapula stability during arm raising. Bringing the humerus in any degree of abductiion or forward flexion, upper trapezius places the stability upon muscular contraction (6).

In the case of paralysis of the upper trapezius, the following effect will be shown: When the shoulder is at rest, the scapula is depressed and the acromion droops forward. The difficulties are increased on elevation of the arm, because the scapula is held closer to the thoracic wall and thoracic spine. Upper trapezius has a rotatory effect which pulls the lower angle of the scapula outward (Figure 5). Our findings demonstrated that decrease in function of this muscle had an important influence upon restoration, because it resulted in no support of scapula in raising the arm in stroke patients with hemiparesis.

Concerning muscle strength the morphological and functional difference is found between male and female. Bischoff's finding indicated that the relative percentage of muscle in men's whole body occupies 41.89%, while that in women's is 35.8%. The growth of muscle exerts a chronological influence upon muscle strength (22). He noted, in grip strength as well as back strength, that women were inferior to men (23-25). Women's muscle strength was, moreover, certified to correspond to 60% of men's and the isometric strength of the upper extremities of the female was on the average about 55% of that of the male (26), which represented the same findings as ours with musculator for scapular elevation strength in the

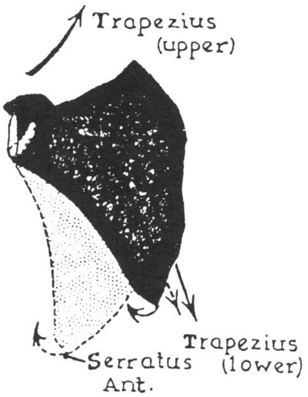

Figure 5. Scapular rotator and force couples (6)

young. Men's strength was about 41 kilograms greater than the women's which corresponded to about 53% (Table 1). Men could generally be suggested to be stronger than women, even after corrections are made for weight and body fat content (27).

Previous studies on the relationship of age and sex to isometric musclar strength are few (23-27), which must be considered in the evaluation of strength. However, studies have shown a progressive decrease in strength, e.g., a 1% per year strength decrease after the age of 20, while they have rarely demonstrated an increase in strength of the muscle concerned in these studies (27, 28). And pinch and grip strength has been mainly focussed on (29). In the adolescent years the increase in upper trapezius muscle strength represented about 10 to 30% between the age groups, especially greater between between 18- and 19-year olds than another group. Regarding the classification of muscle strength of upper trapezius increased with ageing, a one-year grouping should be taken into account, although a significant difference was not found in this investigation. Because the difference of the mean value in muscle strength was a bit too great, it is considered that the more number of subjects should be further investigated.

The normative data collected in this study, as fixed dynamometers have been shown to be reliable (20), provide a means of comparing a patient's scores with normal individuals of the same sex and age and aid in determining a patient's need for therapy and in setting appropriate treatment goals. However, the importance of defining narrow populations for "normal values" should be emphasized.

The measurement with musculator will provide a precise indication of patient's upper trapezius strength. Prepar-ticipation of strength deficits about the scapula may help identify areas in which to concentrate strength training. This study suggests, in spite of the small number of the males at the age of 18 and 20, that muscle strength of upper extremity indicated a clear age-related change between the sexes with the very objective apparatus as musculator. Considerable additional research is requested to further advance our establishment of upper trapezius muscle strength and its assessment.

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