

INFLUENCE OF TESTING POSTURE AND ELBOW POSITION ON GRIP STRENGTH*

CAGATAY BARUT**
PINAR DEMIREL***

SUMMARY: This study was designed to determine the effect of testing posture and elbow position on grip strength in individuals aged between 9 and 18 years. A hand dynamometer (Takei, Tokyo, Japan) was used to measure grip strength of 546 subjects (213 girls, 333 boys) in two positions: (1) standing with elbow in full extension, forearm in full supination (anatomical position) and (2) sitting with elbow in 90° flexion, forearm in semipronation lying on an arm rest. The subjects were asked to squeeze the dynamometer three times with each hand and for each testing positions with 1-minute resting period between each trial in order to overcome fatigue. Paired samples t test was used to evaluate the two testing positions. Only the right grip strength was significantly higher in anatomical position in girls ($p < 0.05$). Besides this result, no statistically significant differences were reported for the left grip strength of girls, and for both hands of boys ($p > 0.05$) when the two testing positions were considered. The testing posture and elbow position had mostly little effect on grip strength of the young age group contrary to adults, which may somewhat be explained with the still ongoing process of the individuals participated in the study.

Key words: Grip strength, posture, elbow position

INTRODUCTION

The hand is an organ specialized for grip and sensation of utmost importance. This makes the hand to be an irreplaceable and subtlest instrument of work as well as a sensory organ of humans. The grip is an act of taking by hand and keeping a firm hold of any object, tool or instrument having different forms for the use of

hand, such as the whole hand or the individual fingers (1,2).

It is prominently accepted that grip and pinch strength measurements provide an objective index of the functional integrity of the upper extremity (3-10). Besides, grip strength can be an important index of general health (4,10,11), nutritional status (12), overall strength (5,11, 13) and the amount of protein reserves in the body (14). Furthermore, the measurement of grip strength has great importance for occupational health purposes (9). The measurement of grip strength is an important component of hand rehabilitation, because it helps establish a baseline for treatment and it is a measure of the effectiveness of therapy (15-17).

*This study has been presented as a poster presentation in "4th Asian Pacific International Congress of Anatomists, Kuşadası, Turkey, September 7-10, 2005."

**From Department of Anatomy, School of Medicine, Bülent Ecevit University, Zonguldak, Turkey.

***From School of Physical Education and Sports, Dumlupınar University, Kütahya, Turkey.

Various studies are available in the literature stressing the effect of testing posture and joint posture on grip strength (3,15,18-23).

The aim of this study was to evaluate the effect of testing posture and elbow position on grip strength in individuals aged between 9 and 18 years.

MATERIALS AND METHODS

A total of 546 subjects (213 girls, 333 boys) aged between 9 and 18 years participated in the study.

Informed consents of all participants were obtained. The Ethics Committee of Karaelmas University also endorsed its approval for the study.

A digital hand dynamometer (Takei) was used to measure grip strength in two positions: (1) The volunteer standing with elbow in full extension, forearm in full supination (anatomical position) and (2) the volunteer sitting on a chair, with the elbow flexed at 90° and the forearm in semipronation lying on an arm rest. Each volunteer was asked to squeeze the dynamometer three times with each hand and for each testing positions. The test was performed on one hand after another. There was a 1-minute resting period between each squeeze in order to overcome fatigue. The mean value of three squeezes was taken into account (11).

Statistical analyses were performed with SPSS for Windows Release 11.01. Statistical comparisons of mean values of the two testing positions were performed with paired samples t test.

RESULTS

Results indicated that only the right handgrip strength was significantly higher in anatomical position in girls ($p < 0.05$) (Table 1). Besides this result, no statistically significant differences were reported for the left grip strength of girls (Table 1), and for both hands of boys and for both hands of the whole study group (Tables 1 and 2)

($p > 0.05$) when the two testing positions were considered.

DISCUSSION

The usual way of measuring grip strength is by using all five fingers to maximally grip onto a handgrip dynamometer (24). There are several studies in the literature establishing grip strength norms of children (4,10,11). There are various studies in the literature evaluating the effect of wrist position on grip strength (19,25-27). Teraoka studied the effect of three body positions (standing, sitting and supine) on grip strength with elbow extended in each test position and indicated that grip strength was found to be stronger in standing position than in sitting position (28).

In the study of Mathiowetz *et al.*, in which grip strength was evaluated with the elbow in 90° and in full extension, it was stated that grip strength scores were significantly higher when the elbow was in a 90° flexed position (21). The elbow flexed at 45° allows higher grip strength than when it is at 90° or with elbow in full extension (9).

In the study of Hillman *et al.* grip strength was highest when subjects were seated in a chair with their elbows unsupported. They also suggested that when the upper limb was not supported, grip strength became stronger due to the synergistic actions of other muscles, but suggested this to be variable (12).

In the study of Kuzala and Vargo, grip strength of 46 participants aged between 21 and 46 years were evaluated. Four elbow positions were used (0°, 45°, 90° and 135° of flexion) with the dominant hand. They stressed that the greatest grip strength was observed with 0° of flexion of the elbow, whereas the weakest was observed with the elbow in 135° of flexion (20).

Table 1: Comparison of right handgrip strength values in two different positions.

	Right handgrip strength (Kgf) (Anatomical position) Mean ± SD	Right handgrip strength (Kgf) (Elbow flexion) Mean ± SD
Girls (n = 213) *	19.59 ± 5.64	19.00 ± 4.76
Boys (n = 333)	23.16 ± 9.55	23.36 ± 9.93
Whole Group (n = 546)	21.77 ± 8.42	21.65 ± 8.57

*Paired samples t test, $p < 0.05$.

Table 2: Comparison of left handgrip strength values in two different positions.

	Left handgrip strength (Kgf) (Anatomical position) Mean \pm SD	Left handgrip strength (Kgf) (Elbow flexion) Mean \pm SD
Girls (n = 213) *	18.98 \pm 4.81	18.96 \pm 4.85
Boys (n = 333)	22.73 \pm 9.43	22.89 \pm 9.80
Whole Group (n = 546)	21.26 \pm 8.15	21.36 \pm 8.45

*Paired samples t test, $p < 0.05$.

In the study of Balogun *et al.*, grip strength of dominant hands of 61 individuals aged between 16 and 28 years were evaluated in four positions. They reported that grip strength was the lowest in the sitting position with elbow in 90° flexion, whereas it was the highest with the subject standing with elbow in full extension. The only significant difference reported was between sitting with elbow in 90° flexion and standing with elbow in full extension (3).

In the study of Boadella *et al.*, grip strength values were found to be higher in standing position versus sitting position, although no statistical analysis is available concerning the comparison of standing and sitting postures (29).

In the study of Su *et al.* it was stated that the differences between 0° shoulder flexion with elbow flexed at 90° versus 0° shoulder flexion with elbow extended were found to be statistically significant; 0° shoulder flexion with elbow flexed at 90° had the lowest scores (15).

All of the studies cited showed differences in maximum handgrip force in different upper limb postures. The underlying causes of changes in strength can be related to variation in muscle force capacity resulting from muscle length, which is related to upper limb posture. Besides, strength is influenced by specific experimental conditions such as testing protocols and the equipment used, where the type of dynamometer is very significant as is the diameter of the gripped sensor. Even for the same experimental conditions different values of maximum force can be obtained for different populations of subjects differentiated by individual factors (30).

In our study grip strength with elbow flexed was found to be higher in boys for both hands, but girls had

higher grip strength values with elbow extended for both hands (Tables 1 and 2). The only statistically significant difference was observed between right handgrip values of girls (Table 1).

It can be suggested that our results are similar to those of Mathiowetz *et al.* (21), Kattel *et al.* (9) and Hillman *et al.* (12) when boys are considered, and also there is controversy with the results of Kuzao and Vargo (20), Balogun *et al.* (3), Boadella *et al.* (29) and Su *et al.* (15) for boys although the differences were not statistically significant. A vice versa result can be claimed to be true when girls were considered. The age group and individual factors can be the reasons for the argument with the literature, as most of the individuals participated in our study are considered to continue to grow up.

From a biomechanical perspective, the length-tension relationships of muscles involved in grip strength are essential and should be taken into account when dealing with issues changing elbow position. Flexor digitorum superficialis is the only primary finger flexor that crosses the elbow joint (31). Therefore elbow position may affect the strength performance of this muscle. As a muscle is placed in a shortened position, it may become incapable of generating the tension necessary to achieve a functional contraction (20). As the elbow is placed in more degrees of flexion, flexor digitorum superficialis is progressively placed in a more shortened position, thereby placing it at a mechanical disadvantage (20). This may explain the decreased grip strength obtained from girls with elbow flexion. But there is still a controversy when boys are considered. This may somewhat be explained with the still ongoing process of the individuals participated in our study.

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Correspondence:

Çağatay BARUT,
 Bülent Ecevit Üniversitesi,
 Tıp Fakültesi, Anatomi Bölümü,
 67600, Kozlu, Zonguldak, TÜRKİYE
 e-mail: cagbarut@yahoo.com