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Original Research Article

Comparison of Hand Grip Strength in Different Positions of Shoulder with Elbow in 90º Flexion and 0º Extension Positions

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ABSTRACT

Objective: The objective of this study is to investigate the effect grip strength in different positions of elbow with shoulder neutral and flexion while the subject is in standing position.
Methods: 30 students from the Vinayaka Mission College of physiotherapy were selected randomly with the age group of 18-25years and divided into group 1 (n=15) male and group 2 (n=15) female. Testing done in standing posture, the right handed dominant subjects were included in this study. Grip-strength measurements were taken by the shoulder 0ºneural flexion and 90ºflexion with respect to elbow positioned at 0 degree extension and 90 degrees of flexion. Grip strength was used as an outcome measure for the study.
Results: The highest mean grip strength was recorded; when the shoulder was positioned in neutral flexion with elbow in 0 degree extension with respect to the wrist in neutral (42.90±11.87). The lowest mean grip strength was recorded; when the shoulder was positioned in 90 degree flexion with elbow in 90 degree flexion with respect to wrist in neutral (28.83±13.52). Comparison between the gender shows a significant difference between the male and female in which male has greater grip strength than the female in all positions. The highest mean grip in males and females were documented when the shoulder was positioned in neutral flexion with elbow in 0º extension with respect to the wrist positioned in neutral. The results of ANOVA findings indicated significant differences ($p<0.05$) in grip strength between shoulder 90º flexion with respect to elbow 90º flexion and 0º extension. Pearson Product-Moment Correlation Coefficient of age and different positions of shoulder with respect to the elbow positions and results showed that there is No linear relationship between age and different positions of the shoulder and elbow ($r=0$).
Conclusion: This study confirms that various joint positions can affect grip strength, especially the elbow and shoulder joints with respect to wrist positions neutral. It would be reasonable to evaluate the hand injured patient's grip strength using different combined shoulder and elbow positions to determine their maximal grip force. Clinically useful information may be derived from these findings and are valuable in the evaluation and rehabilitation training of hand injured patients.

Key words: Grip Strength, Hand Strength Testing, Elbow Position, Shoulder Position.

INTRODUCTION

Grip strength is a part of 'hand strength' which use as an application of force to pull or suspend an object. It is one of the important parts of the human body which requires the ability to manipulate activity of daily living, work and leisure. Important functions of the hand are grasping, applying muscular forces, to control or manipulating objects either it is small or large size. Hand grip strength measures the amount of static force that

the hand is capable to squeeze around a dynamometer. The force has most commonly been measured in kilograms, pounds, but also in milliliters of mercury and in Newton.

Disorders of hand function will cause many difficulties due to impairment of motor and sensory function, thus will lead to inability in achieving good grip strength and performing daily tasks. This is one of the reasons why people with grip strength problems; seek rehabilitation in order to regain back their hand function.

Based on the clinical perspective, measurement of grip strength is an important element in hand rehabilitation. It provides an assessment based on observation and subjective impression and provide information regarding hand function. By measuring grip strength, it will assess the patient initial limitation and provide a quick reassessment of patient progress throughout the treatment given. [1] Grip strength is related to and predictive of other health conditions, although the relationship is not stated to be causative. [2,3] Normal hand grip strength is positively related to normal bone mineral density in postmenopausal women. [4] Some researchers suggest that grip strength can be a screening tool for women at risk of osteoporosis. [5]

Longitudinal studies suggest that poor grip strength is predictive of increased mortality from cardiovascular disease and from cancer in men, even when factors of muscle mass and body mass index are adjusted. [6,7] Hand grip strength is negatively associated with physical frailty even when the effects of body mass index (BMI) and arm muscle circumference are removed. [8] Researchers have suggested that the factor related to frailty and disability in later life is the manner in which muscles are used, and this can be measured by hand dynamometry. [8]

Grip strength is frequently evaluated in clinical settings as an indicator of disease activity (Rhind et al, 1980). [9] It is evaluated as a component of hand function. It is widely accepted that grip strength provides an objective index of the functional integrity of the upper extremity (Myers et al, 1973; [10] Mayers et al, 1982). [11] American society of hand therapists suggested a standardized testing protocol for handgrip strength. Standardized grip strength testing procedures have been recommended to provide even greater objectivity of measurement in normal circumstances. In a clinical setting number of reasons it may be impossible to follow standardized testing procedures. [12]

Alternative testing position may be useful, however, in identifying positions, which maximize biomechanical abilities and may assist in the design of environments and tools (Richards et al, 1996). [13] Therefore, alternative testing positions may be useful, however, in identifying positions which maximizes biomechanical abilities and may assist activities of daily living. Dominant hand differs from each person to others. The common perception regarding the dominant hand is, the hand with frequently used will produce more strength compare to the opposite hand regarding the hand dominance. [14]

Studies on the effect of shoulder and elbow positions on grip strength remain controversial. And therefore, alternative testing positions may be useful, however, in identifying positions which maximizes biomechanical abilities and may assist activities of daily living. The main objective of the current study is to establish the variation in grip strength in different positions of the shoulder (neutralflexion and 90^0flexion) and elbow (90^0flexion and 0^0extension) with wrist in neutral position. Thus, there is a need for assessing hand grip strength from different body positions to allow clinicians to establish objective goals, address both physical and functional limitations, establish a methodology that is clinically relevant, easy to perform and reproducible

and guide a rehabilitation program to return to function.

MATERIALS AND METHODS

A simple random sample of thirty healthy subjects from the student population of Vinayaka Missions College of Physiotherapy, Salem (15 males, 15 females) in the age group of 18-25 years participated in the study. Subjects signed informed consent forms after being provided with a brief description of the study. Ethical approval was obtained from Research Committee of Vinayaka Missions University. The exclusion criteria for this study included left hander, any previous history of right upper extremity abnormalities, inflammatory joint diseases, neurological disorder or injury to upper limb and other health conditions on right side.

The test was administered by using standard Jamar Grip strength Dynamometer, which is known as the most efficient tool for obtaining objective clinical measurement of grip strength, [15] and same dynamometer was used throughout the study. The participants were instructed to put maximum force on the dynamometer. For handgrip strength, standard instructions were followed, and the scores of 3 successive trials were recorded for each hand with at least 2 minutes recovery between each effort. [16] Hand grip dynamometer was calibrated before each assessment.

All the subjects reported themselves to be in good health. Prior to the procedure subjects who met the inclusion criteria were assessed and evaluated thoroughly. Each subject's gender, age, height and weight were recorded. Subjects in the standing position were instructed to hold their forearm and wrist joint neutral for one set of four testing positions.

1. Shoulder neutral flexion with elbow flexed to 90º.
2. Shoulder neutral flexion with elbow 0º extension.
3. 90º of shoulder flexion with elbow flexed at 90º.
4. 90º of shoulder flexion with elbow 0º extension.

Prior to the commencement of data collection, a practice trial was given to familiarize the subjects with the dynamometer. Before testing, the examiner demonstrated how to hold the handle of the dynamometer. The same instructions were given for each trial. After the subject was positioned with the dynamometer, the examiner instructed the subjects to "squeeze as hard as possible … harder … harder. Relax". To control for the effects of fatigue, subjects were asked to rest for 2 minutes. For right dominant hand, three trials were performed in each position. Mean of 3 trials was recorded for calculation purpose. As the dominant hand has a 10% stronger grip than the non-dominant hand. [17]

Statistical analysis: The descriptive statistics of age, weight and height were recorded. Data was computed with one way repeated measures of analysis of variance procedure ANOVA to find the significant difference between the shoulder positions with respect to elbow positions. The correlation between dependent variable handgrip strength among each position and independent variable age was analyzed through Pearson Product Moment Correlation Coefficient (r).All analyses were performed using SPSS version 23.

RESULTS

Table 1 shows, the demographical data's of the study population are summarized.

Table 2 shows the means and standard deviations of grip strength scores for all four positions. The highest mean grip strength was recorded; when the shoulder was positioned in neutral flexion with elbow in 0 degree extension with respect to wrist in neutral (42.90±11.87). The lowest mean grip strength was recorded; when the shoulder was

positioned in 90 degree flexion with elbow in 90 degree flexion with respect to the wrist in neutral (28.83±13.52).

Table 1: Descriptive statistics of physical characteristics of male and female

Descriptive Statistics Male					
	N	Minimum	Maximum	Mean	SD
Age in years	15	18	25	21.27	2.282
Weight in kg	15	55	74	62.80	5.213
Height in cm	15	148	172	159.27	7.648
Descriptive Statistics Female					
	N	Minimum	Maximum	Mean	SD
Age in years	15	18	25	20.93	2.344
Weight in kg	15	49	63	55.53	4.658
Height in cm	15	138	167	151.00	9.509

Table 2: Descriptive statistics of different position of shoulder with elbow positions

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Shoulder Neutral flexion with Elbow 90º flexion	30	22	64	37.20	12.491
Shoulder Neutral flexion with Elbow 0º extension	30	24	68	42.90	11.871
Shoulder 90º flexion with Elbow 90º flexion	30	12	57	28.83	13.524
Shoulder 90º flexion with Elbow 0º extension	30	9	54	29.07	13.628

Table 3: Means and Standard deviation of grip strength scores for all positions for different gender

Descriptive Statistics	**MALE (N=15) Mean**	**FEMALE (N=15) Mean**	**MALE (N=15) SD**	**FEMALE (N=15) SD**
Shoulder Neutral flexion with Elbow 90º flexion	38.53	35.87	12.972	12.293
Shoulder Neutral flexion with Elbow 0º extension	44.13	41.67	12.397	11.617
Shoulder 90º flexion with Elbow 90º flexion	40.47	17.20	8.741	3.529
Shoulder 90º flexion with Elbow 0º extension	40.40	17.73	9.826	3.595

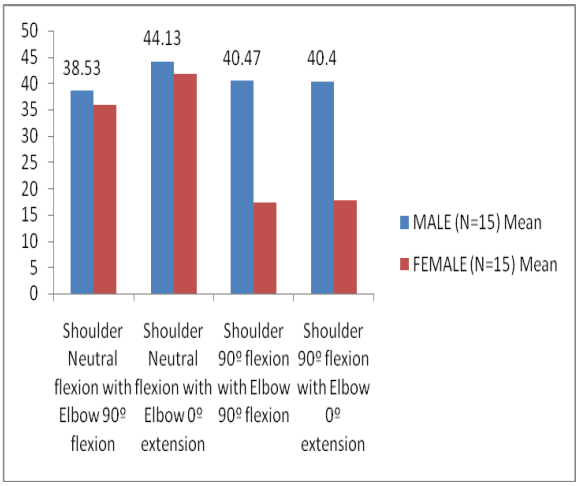

Table 3 shows the means and standard deviation of grip strength scores for all positions for different gender. The highest mean grip in males and females were documented when the shoulder was positioned in neutral flexion with elbow in 0º extension with respect to wrist positioned in neutral. While the lowest mean grip strength scores in males were recorded when the shoulder was positioned in neutral flexion with elbow 90º flexion. While the lowest mean grip strength scores in females were recorded when the shoulder was positioned in 90º flexion with elbow 90º flexion.

Table 4: One way ANOVA determining grip strength differences shoulder neutral flexion with respect to elbow 90º flexion and 0º extension.

ANOVA					
SHOULDER NEUTRAL FLEXION WITH ELBOW 90º FLEXION AND 0º EXTENSION					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3836.300	21	182.681	2.123	.137
Within Groups	688.500	8	86.063		
Total	4524.800	29			

Table 5: One way ANOVA determining grip strength differences in shoulder 90º flexion with respect to elbow 90º flexion and 0º extension

ANOVA					
SHOULDER 90º FLEXION WITH ELBOW 90º FLEXION AND 0º EXTENSION					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5049.333	20	252.467	8.916	.001
Within Groups	254.833	9	28.315		
Total	5304.167	29			

Table 4 shows the one way ANOVA determining grip strength differences in shoulder neutral flexion with respect to elbow 90º flexion and 0º extension. The results of ANOVA findings indicated no significant difference (P>0.05) in grip strength between shoulder neutral flexion with respect to elbow 90º flexion and 0º extension.

Table 5 shows the one way ANOVA determining grip strength differences in shoulder 90º flexion with respect to elbow 90º flexion and 0º extension. The results of ANOVA findings indicated significant differences (P<0.05) in grip strength between shoulder 90º flexion with respect to elbow 90º flexion and 0º extension.

Table 6: One way ANOVA determining grip strength differences in shoulder neutral and 90º flexion with respect to elbow 90º flexion

ANOVA					
FLEXION SHOULDER NEUTRAL & 90º FLEXION WITH ELBOW 90º FLEXION					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3012.467	17	177.204	1.406	.278
Within Groups	1512.333	12	126.028		
Total	4524.800	29			

Table 7: One way ANOVA determining grip strength differences in shoulder neutral and 90º flexion with respect to elbow 0º extension

ANOVA					
SHOULDER NEUTRAL & 90º FLEXION WITH ELBOW 0º EXTENSION					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2026.200	20	101.310	.443	.938
Within Groups	2060.500	9	228.944		
Total	4086.700	29			

Table 6 shows the one way ANOVA determining grip strength differences in shoulder 90º flexion with respect to elbow 90º flexion and 0º extension. The results of ANOVA findings indicated no significant difference (P>0.05) in grip strength between shoulder 90º flexion with respect to elbow 90º flexion and 0º extension.

Table 7 shows the one way ANOVA determining grip strength differences in shoulder neutral and 90º flexion with respect to elbow 0º extension. The results of ANOVA findings indicated no significant difference (P>0.05) in grip strength between shoulder neutral and 90º flexion with respect to elbow extension.

Table 8: Pearson Product-Moment Correlation Coefficient of age and shoulder neutral flexion with respect to elbow 90º flexion

Correlations			
		Age in Years	Shoulder Neutral flexion with Elbow 90º flexion
Age in Years	Pearson Correlation	1	-.098
	Sig. (2-tailed)		.608
	N	30	30
Shoulder Neutral flexion with Elbow 90º flexion	Pearson Correlation	-.098	1
	Sig. (2-tailed)	.608	
	N	30	30

Table 9: Pearson Product-Moment Correlation Coefficient of age and shoulder neutral flexion with respect to elbow 0º extension

Correlations			
		Age in Years	Shoulder Neutral flexion with Elbow 0º extension
Age in Years	Pearson Correlation	1	-.193
	Sig. (2-tailed)		.306
	N	30	30
Shoulder Neutral flexion with Elbow 0º extension	Pearson Correlation	-.193	1
	Sig. (2-tailed)	.306	
	N	30	30

Table 10: Pearson Product-Moment Correlation Coefficient of age and shoulder 90º flexion with respect to elbow 90º flexion

Correlations			
		Age in Years	Shoulder 90º flexion with Elbow 90º flexion
Age in Years	Pearson Correlation	1	.018
	Sig. (2-tailed)		.923
	N	30	30
Shoulder 90º flexion with Elbow 90º flexion	Pearson Correlation	.018	1
	Sig. (2-tailed)	.923	
	N	30	30

Table 11: Pearson Product-Moment Correlation Coefficient of age and shoulder 90º flexion with respect to elbow 0º extension

Correlations			
		Age in Years	Shoulder 90º flexion with Elbow 0º extension
Age in Years	Pearson Correlation	1	-.030
	Sig. (2-tailed)		.874
	N	30	30
Shoulder 90º flexion with Elbow 0º extension	Pearson Correlation	-.030	1
	Sig. (2-tailed)	.874	
	N	30	30

Table 8,9,10 & 11 shows the Pearson Product-Moment Correlation Coefficient of age and different positions of shoulder with respect to the elbow positions and results showed that there is No linear relationship between age and different positions of the shoulder and elbow (r=0).

DISCUSSION

Hand grip strength is a useful, functional measure of the integrity of upper extremity, however many studies examined it from selected positions (supine, sitting, standing), with no emphasis on other derived positions that are used in a clinical setting. [18] There are many factors influencing the degree of grip strength produced, however, it is of importance to measure grip strength in a body position that is identical to that used in normative studies. [19] It is of high importance in the early mobilization of patients; however, some patients cannot tolerate the upright position, and others perform strengthening exercises from recumbent positions. Their positions may affect hand grip measurement for evaluation and treatment. Therefore, testing the hand grip strength from different positions is of clinical importance.

In this study, the hang grip strength value was taken in the standing position, however, the higher value of hang grip strength obtained from standing position. These findings are in close agreement with the results of previous studies [20,21] who found that a greater strength was obtained when the subjects were standing compared to the sitting position. On a physiological basis, this may be due to the increased temporal and spatial summation of the contracting muscles in the standing position. In addition, sitting position induces relaxation while standing position stimulates cortical and peripheral arousal. Furthermore, the synergistic effect of the lower extremity muscles and corresponding sensory feedback is great in standing rather than in a sitting. [20]

This study has investigated comparative study of grip strength at different positions of the shoulder with elbow in 90º flexion and 0º extension positions. The results reveal that the highest mean grip strength was recorded; when the shoulder was positioned in neutral flexion with elbow in 0 degree extension with respect to wrist in neutral (42.90±11.87). The lowest mean grip strength was recorded; when the shoulder was positioned in 90 degree flexion with elbow in 90 degree flexion with respect to wrist in neutral (28.83±13.52) (Table

no.2). These findings indicated that the effect of the upper extremity posture of maximum grip strength revealed that the shoulder joint angle has an influence on grip strength performance**.** [22] It may be speculated that the synergistic muscles of the back and shoulder may be able to act to their best advantage, which would theoretically increase their efficiency for optimum exertion according to the principle of length-tension relationship. [23,24]

The mean grip strength scores were higher for all the four positions when wrist was positioned in neutral (Table 2). This may be explained on the basis of the length–tension relationship of active contractile elements within a muscle. [25] It may be that when the wrist is positioned in neutral with a slight ulnar deviation the muscle compartments for individual fingers attain an optimal length for maximum active force production. As the wrist moves in full extension the associated muscle compartment length for each finger exceeds the optimal range leading to decrease in grip force. In our study results were further analyzed in males and females in all four positions. The highest mean grip in males and females were documented when the shoulder was positioned in neutral flexion with elbow in 0º extension with respect to wrist positioned in neutral. While the lowest mean grip strength scores in males were recorded when the shoulder was positioned in neutral flexion with elbow 90º flexion. While the lowest mean grip strength scores in females was recorded when shoulder was positioned in 90º flexion with elbow 90º flexion (Table No.3).

The differences in strength between the genders to their physical characteristics rather than to the biological differences. [20] Data was computed with one way repeated measures of analysis of variance procedure ANOVA to find the significant difference between the shoulder positions with respect to elbow positions. The results of ANOVA findings indicated significant differences ($P<0.05$) in grip strength between shoulder 90º flexion with respect to elbow 90º flexion and 0º extension (Table 5) and no significant difference ($p>0.05$) in grip strength between shoulder neutral flexion with respect to elbow 90º flexion and 0º extension, shoulder 90º flexion with respect to elbow 90º flexion and 0º extension and shoulder neutral and 90º flexion with respect to elbow extension. (Table 4), (Table 6), and (Table 7) respectively.

This study correlated the hand grip strength age with subjects' age and found no linear relationship between age and different positions of the shoulder and elbow ($r=0$) in both males and females but this result is contrasted to the study done by Chandrasekaran et al. (2010) who stated that grip strength correlated moderately to high with age in both genders. [2]

This study confirms that various joint positions can affect grip strength, especially the elbow and shoulder joints with respect to wrist positions neutral. It would be reasonable to evaluate the hand injured patient’s grip strength using different combined shoulder and elbow positions to determine their maximal grip force.

CONCLUSION

The changes in elbow position on grip strength are observed with variations in shoulder positions and also concluded that the difference of grip strength occurs with the testing posture and degree of elbow positions between genders.

The practical implications of this study are that grip hand strength management from different positions assists the patients in restoring maximal function in activities of daily living, vocational skills, and avocational interests after injury or surgery or as a consequence of a disease affecting hand mobility. Hence the findings are valuable in the

evaluation and rehabilitation training of hand injured athletes or patients.

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