THE EFFECTOF FOREARM ROTATION ON STRENGTH OF ELBOW MUSCLES AT DIFFERENT SHOULDER POSITIONS

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ABSTRACT

Background: *The elbow is a critical element for a functional upper extremity. The primary functions of the elbow are to position the hand in space, act as a fulcrum for the forearm, and allow for powerful grasping and fine motions of the hand and wrist.*

Purpose: *to determine the difference between (anatomical zero) AZ handgrip and 90° pronated hand grip positions on elbow muscle performance at 45° and 80° shoulder abduction.*

Method: *Eighty subjects (Males and Females), from 20 to 30 years old participated in this study, and were classified into four groups of equal number. Groups I and II were tested at AZ handgrip position with 45° and 80° shoulder abduction respectively. Groups III and IV were tested at 90 degree pronated handgrip position with 45° and 80° shoulder abduction respectively. They were assessed by using Biodex 3 to measure peak torque to body weight (PT/BW) and the agonist antagonist ratio of elbow flexor and extensor muscles at angular velocity 60° / second.*

Results: *Results showed that there were no significant differences between AZ handgrip and 90° pronated hand grip positions on elbow muscle performance at 45° and 80° shoulder abduction.*

Conclusion: *strengthening exercises of elbow flexors and extensors muscles can be done from any position of the four positions due to there is no significant difference in PT/BW and the agonist antagonist ratio of elbow flexors and extensors muscles between the four positions.*

Key words:-*AZ handgrip – isokinetic dynamometer - torque –muscle strength.*

INTRODUCTION

The elbow is a critical element for a functional upper extremity. The upper extremity consists of a linked system between the shoulder, elbow, wrist, and hand. The primary functions of the elbow are to position the hand in space, act as a fulcrum for the forearm, and allow for powerful grasping and fine motions of the hand and wrist. Loss of elbow function can cause significant disability and affect activities of daily living, work-related tasks, and recreational activities. [1]

When evaluating the elbow's flexors and extensors, there are two main set-up procedures that may influence test results. The first involves an anatomical zero handgrip position (AZ-pos) with the forearm in full supination. The second method has a handgrip position with the forearm pronated to 90° from

full supination (90°-pos). This position is normally favoured by clinicians when testing the elbow joint**.**[2]

A number of studies documented cases of forearm/elbow injuries inindustries, most of which included forms of lateral epicondylitis, which is associated with forceful laborious tasks, e.g., wallboard installation, roofing, masonry, foundries, building construction, furniture making, paper products manufacturing and meat dealers, all occupations that involve repetitive, forceful work involving the hands and armsand requiring pronation and supination.[3,4,5]

There was limited number of published works that were study the effect of forearm and shoulder positions on elbow flexor and extensor muscle groups. All previous studies focused on effect of one variable only as shoulder, forearm or hand positions on strength of elbow muscles with neglect other variables while there is some information about peak torque and agonist- antagonist ratio of elbow flexion - extension are available.

This study was designed to answer the following question; does the forearm rotation have an effect on strength of elbow muscles at different shoulder positions?

METHODOLOGY

The study was done at the isokinetic laboratory and out clinic of Physical Therapy Faculty, Cairo University. Eighty normal subjects from both sex, with age ranged from 20 to 30 years, BMI (18.5–24.9 kg/m^2).[6] All subjects signed a written informed consent form.
Exclusion Criteria include any orthopedic surgery in upper limb and any medical condition as diabetes mellitus, recent myocardialinfarction, hypertension or an acute infection.[7]

Subjects were randomly assigned into four equal groups:
Group I: - 20 subjects were tested at AZ handgrip position with 45° shoulder abduction. Group II: -20 subjects were tested at AZ handgrip position with 80° shoulder abduction. Group III: - 20 subjects were tested at 90° pronated handgrip position with 45 °shoulder abduction. Group IV: - 20 subjects were tested at 90° pronated handgrip position with 80° shoulder abduction.

Instrumentation:-
1-The Biodex system 3isokinetic dynamometer:-
It is one of the most comprehensive computer device provided with attachments and isolation straps for every part of the body. Computer system is provided with a menu of programs which controlled through the control panel or the computer software programs and a testing chair for testing the subjects. It has been widely used in research, clinical setting and rehabilitation to objectively assess factors of muscle performance that would
otherwise be difficult to obtain using manual testing techniques. It measures the internal torque produced by a group of muscles while the bony segment is maintaining a constant angular velocity and range of motion. The system was equipped with a specific trunk testing and rehabilitation chair with a special forward reclined sitting surface seat, adjustable straps and knee blocks for prevention of forward sliding .[8]

2-Electric Ginometer:-
An electrogonimeter enables a quick measurements of joint positions and continuous joint motion**.**[9]

Measurement procedures:-

1- Subjects were asked to sign a consent form including the procedures of the testing and their willingness to participate.
2- As a preparation, isokinetic system was first calibrated according to the parameters of performance.
3- Positioning and stabilization:- Each subject was asked to sit erect , so that the trunk was perpendicular to the floor and the legs were firmly supported with his elbow joint of the dominant side positioned in line with the pump shaft of the isokinetic machine. The trunk was stabilized with a diagonal shoulder strap; this was to prevent flexion and lateral flexion of the trunk during test. The pelvis was secured with a belt cross the anterior iliac spines. The adjustable arm of the chair was used for supporting the upper arm orientation at these angles (45°and 80° abduction) after detecting these angles of the shoulder joint by using electric goniometer. The upper arm was stabilized to the adjustable arm test of the chair with a strap to prevent displacement of the upper arm.
4- The subject was trained to be familiarized with the way of how to grasp the handgrip of the machine the thumb and the fingers with the elbow in full extension, he was instructed to perform three warms up elbow flexion tasks exerting maximum effort then with elbow in full flexion, he was instructed to perform three warms up elbow extension tasks exerting maximum effort.
5- At each shoulder angle (45° and 80° abduction) the movement of the elbow joint was performed from two positions of the forearm .One from full supination of the forearm and second from 90° pronation of the forearm.
6- The elbow flexion movement was performed from 0° elbow flexion to mid-range (75°). {The range of the dynamometer arm set for the arc of motion from 0° to 75°} then the elbow extension movement was performed from full elbow flexion to the mid-range (75°). {The range of the dynamometer arm set for the arc of motion from 0° to 75°}.
7- During the test, the movement was performed three times with maximum effort and the PT/BW was measured in each time the in N.m/kg.
8- The sequences of testing the shoulder positions were randomly varied among the subjects.

RESULTS
The analysis of these data was done using SPSS 20; included descriptive analysis of means and standard deviation (SD) of subjects general characteristics and and inferential statistics, ANOVA of subjects' general characteristics and of measured variables; PT/BW, agonist antagonist ratio of elbow flexion and extension at 60°/ sec. The data in table (1)

represent the mean ± SD of age, height and weight of four groups.

I - Peak torque to body weight:-

Means values within groups of elbow flexion and extension:

As shown in **table (2)**, the mean values and SD of elbow flexion Peak torque to body weight (PT/BW) for subjects in groups (I, II, III and IV) were (39.32 ± 10.34), (32.81±8.55), (41.15 ±12.45) and (36.2±7.58) N.m/kg respectively.

As shown in **table (2),** the mean values and SD of elbow extension (PT/BW) for subjects in groups (I, II, III and IV) were (35.8 ±11.16), (34.6±10.5), (40.25 ±12.26) and (41.5±12.3) N.m/kg respectively.

ANOVA test revealed that there were no significant differences between the four groups in elbow flexion and extension (PT/BW), where p values were 0.726 and 0. 674 respectively.

II -Agonist antagonist ratio

Means values within groups:

As shown in table (2), the mean values and SD of agonist antagonist ratio for subjects in groups (I, II, III and IV) were (100.3±12.22), (94.6±13.2), (90.2±11.74) and (88.4±12.13) respectively. ANOVA test revealed that there were no significant differences between two groups in agonist antagonist ratio, where p values were 0.482.

Table 1:General characteristics of subjects in four groups

General characteristics	Age (yrs)	Height (cm)	Weight (kg)
Group I Mean ±SD	23.15 ±1.95	164.95±9.72	63.5±12.26
Group II Mean ±SD	22.65±0.67	169.2±9.83	69.6±12.84
Group III Mean ±SD	23.75±1.91	171.9±4.02	70.3±7.5
Group IV Mean ±SD	22.7±1.34	168.45±9.19	70.8±12.4
F value	2.14	2.25	1.76
P-value	0.102	0.089	0.161

Table (2): Mean values of elbow flexors and extensors (PT/BW) for subjects in the four groups

Items	Elbow flexion (PT/BW)	Elbow extension (PT/BW)	Agonist antagonist ratio
Group I **Mean ± SD**	39.32 ±10.34	35.8 ±11.16	100.3±12.22
Group II **Mean ± SD**	32.81±8.55	34.6±10.5	94.6±13.2
Group III **Mean ± SD**	41.15 ±12.45	40.25 ±12.26	90.2±11.74
Group IV **Mean ± SD**	36.2±7.58	41.5±12.3	88.4±12.13
F value	12.8	9.1	7.35
P-value	0.726	0. 674	0.482

DISCUSSION

This study was conducted to compare the effect of AZ hand grip position and 90° pronation of forearm on strength of elbow muscles at different shoulder positions. This study was conducted on normal subjects to provide baseline to know which is better to use in rehabilitation protocol for elbow joint problems as regarding to muscular performance provided by isokinetic muscle force.

The findings of this study show that there were no significant differences between group I which was tested at AZ handgrip position with 45° shoulder abduction and group II which was tested at AZ handgrip position with 80° shoulder abduction and group III which was tested at 90 degree pronated handgrip position with 45° shoulder abduction and group IV which was tested at 90° pronated handgrip position with 80° shoulder abduction in (PT/BW) of elbow flexion and extension and agonist antagonist ratio.

The findings of this study are in agreement with (**Papathanasiouetal., 1989**) who demonstrated that flexor peak torque values decreased with increasing abduction from 45° to 80⁰ with the forearm in mid position while extensors values remained unaffected and there was no significant differences between the torque values of elbow flexors and extensors at both shoulder positions. Statistical analysis showed that no significant differences existed between the two muscle groups(elbow flexors and extensors) during shoulder abduction 45° and 80° under all circumstances, as the peak torque and the peak torque to body weight ratio values are concerned.

The findings of this studies are in disagreement with **(Lategan and Kruger, 2007)**.who demonstrated that there were a significant differences in measuring elbow flexion and extension peak torque between the two groups.one group measured elbow flexion and extension peak torque with the forearm in AZ hand grip position and the other group measured elbow flexion and extension peak torque with the forearm in 90⁰ pronation.

The findings of this studies are in disagreement with (**Mandalidis and O'Brien ,2001**)[12]who demonstrated that Isokinetic moment of elbow flexors was significantly greater with the forearm in supination compared to the neutral position (p < 0.001) regardless of the side or the isokinetic velocity used

Conflict of Interest: None

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