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Difference in Isokinetic Strength of Shoulder Joint Muscles in Dominant versus Nondominant Upper Extremities in Children

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Abstract: *Muscle training plays an important role intreatment of shoulder joint disorders. Strength of one upper extremity (UE) can be used as a comparison for the other one.*
Objective: *The purpose of this study was to determine the difference in isokinetic peak torque of shoulder joint flexors and extensors in the dominant versus non-dominant UE. Relationship between dominant and non-dominant shoulder joint flexor and extensor muscles was also investigated.*
Methodology:*Shoulder isokinetic measurements were obtained from fifty children (30 boys and 20 girls) with age range 8-12 years at two angular velocities (60◦ and 180◦/sec) during flexion and extension movements.****Results****: There was significant difference in peak torque of shoulder joint flexors at both speeds and in shoulder joint extensors at velocity 180°/sec only in the dominant compared to the non-dominant UE.In addition, there was significant positive correlation between peak torque of shoulder joint flexors and extensors in both UE.****Conclusion:*** *Results of the current study proved that strength of shoulder joint flexor and extensor muscles in the dominant UE is greater than the non-dominant one. Therefore, it seems inappropriate to use isokinetic strength of the non-dominant shoulder joint as normal baseline data for the affected side without proper handedness adjustment.*
Keywords: *Children,Isokinetic Testing,Muscle Strength,Shoulder Joint.*

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I. Introduction

Normal active range of motion (ROM) and strength in all directions in upper extremity (UE) joints is required to carry out activities of daily living (ADL) whether they are basic activities of daily living (BADL) or instrumental activities of daily living (IADL) **(1, 2, 3)**. When daily activities such as dressing or eating are hindered due to decreased ROM, then compensatory movements **(4, 5, 6, 7, 9)**, or adaptive equipments or even assistance from other individuals will be utilized. Still the long-term effect of these solutions may have physical, psychological, social, and/or financial disadvantages **(6, 10, 11)**.

Maintaining or restoring joint ROM and muscle strength is a main treatment goal for physical therapists were findings about patient's impairment require comparison with some reference value. Establishment of normative strength values in healthy population allows proper strength **(12, 13).**Impaired ROM and strength in any joint can occur at all ages as a result of various medical conditions such as trauma, plexus lesions etc. **(14, 15, 16, 17, 18, 19, 20, 21).**

The shoulder joint is a proximal joint in the UE. Determining strength of the muscles surrounding it is important for movement and stability of the UE. Isokinetic testing provides quantitative data of muscle performance which proved beneficial in detection of muscle weakness, follow-up of the patient after treatment and planning for a return to sport activity. To evaluate muscle strength, clinicians usually evaluate both sides with an assumption of bilateral equivalence **(22)**.Many studies reported that shoulder flexion and extension movements, in addition to abduction and adduction are the most used shoulder movements in various studies**(1)**.

The purpose of the current study was to determine the difference in isokinetic peak torque of shoulder joint flexors and extensors in the dominant versus non-dominant UE in healthy nonathletic children. Relationship between dominant and non-dominant shoulder flexor and extensor muscles was also investigated.Such normal baseline data is essential for the diagnosis and evaluation purposes, quantifying the

severity ofimpairments, examining effectiveness of intervention programs and development of treatment strategies.

II. Materials and Methods

Subjects

Fifty children, 30 boys and 20 girls, (10.1± 1.5 years, 140.1 +9 /cm, and 10.1 +1.5 /kg) participated in this study. Children were included in this study if their age ranged from 8-12 andwere able to understand and follow instructions and verbal commands during the evaluation procedures.They were excluded if they had a history of injury or surgery that might affect strength or ROM of shoulder joint and/or muscles in both UE, participated in any regular sports activity and currently had symptoms involving dominant or non-dominant UE that limited their abilities to participate in isokinetic testing.

Instrumentation

Isokinetic dynamometer (System 3, Biodex Medical Systems, Shirley, NY) was used in the current study to evaluate the concentric strength of shoulder flexor and extensor muscles peak torque in Newton-meters (Nm).

Procedures

Prior to the process of evaluation procedures of the study were explained fully to parents or guardians of children participating in the study and any questions concerning the study were fully explained. Upon their approval, each parent or guardian was asked to sign a consent form. Parents and guardians were advised that they can terminate the trial at any time if they felt any concerns.

The evaluation procedure consisted of a data collection sheet and the isokinetic dynamometer and lasted approximately one hour. Parents or guardian could enter the evaluation lab if they requested that.

Each child sat on the chair of the isokinetic dynamometer and was strapped by shoulder and waist belts to minimize whole body movement during muscle function testing. Gravity corrections were performed and both UE were tested, the dominant side first.

The test consisted of two speeds, 60◦ and 180◦/sec and one movement plane (flexion and extension).Both shoulders, in the dominant and non-dominant UE were tested with the samepositions and ROM.

Each child was given three submaximal trials prior each testing velocity to familiarize him/her with the equipment and the testing procedures. The test protocol consisted of five repetitions at an angular velocity of 60◦/sec, then a two-minute rest period, followed by same extremity tested with a maximum of ten repetitions at a speed of 180◦/sec. A five-minute break rest was given between measurements for both shoulders. Each child was given standardized instructions of "push as hard as possible". After finishing the process of evaluation, each child was unstrapped from the isokinetic chair and helped down.

Statistical Analysis

Data analysis was performed using the Statistical Package for Social Science (SPSS) Software (version19) for windows. The p value was set at 0.05. Descriptive statistics, including mean and standard deviation were calculated for all variables of the study. Paired test was used to compare between shoulder flexor and extensor muscles peak torque. Person correlation coefficient was used to determine thelinear relationship between dominant and non-dominant UE in terms of strength.

III. Results

Normality test

Data was screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilk test for normality showed that the measured variables were normally distributed.

Demographic Data:

In this study, 50 children participated, their mean age (years), weight (kilograms/kg), and height centimeters/ cm were (10.1± 1.5),t (35.6± 6.5) and (140.1± 9) respectively **(table 1)**.

Table 1. Demographic Data

	Mean + SD
Age	10.1 ±1.5
Weight	35.6 ±6.5
Height	140.1 ±9

Comparison between the dominant (right) and non-dominant (left)isokinetic peak torque of the shoulder joint flexors and extensors muscles

Comparison between dominant (right) and non-dominant (left) isokinetic peak torque of the shoulder jointflexorsshowed significant difference between both sides at velocity 60°/sec and 180°/sec (p= 0.008 and 0.001) respectively. On the other hand, there was significant difference in isokinetic peak torque between the dominant (right) and non-dominant (left) shoulder joint extensors only at speed 180°/sec (p = 0.001) **(table 2)**.

3.3 Correlation between the dominant (right) and non-dominant (left) isokinetic peak torque of the shoulder joint flexors and extensors muscles

There was significant positive very strong correlation between the dominant (right) and non-dominant (left)isokinetic peak torque of the shoulder joint flexor musclesat both velocities 180°/secand60°/sec(p = 0.001, 0.001) respectively. On the other hand, there was significant positive moderate correlation between the dominant (right) and non-dominant (left) isokinetic peak torque of the shoulder joint extensor muscles at velocity 180°/sec(p = 0.001) andsignificant positive weak correlation between the dominant (right) and non- dominant (left) isokinetic peak torque of the shoulder joint extensor muscles at velocity 60°/sec(p = 0.001), as shown in **table (3).**

Table (1). Comparisonbetween dominant (right) and non-dominant (left) isokinetic peak torque of the shoulder joint flexor and extensor muscles

Items	**60°/sec**		**180°/sec**	
	Flexors	**Extensors**	**Flexors**	**Extensors**
(Dominant) Right	30.9±9.5	29.3±8.8	24.8 ±6.3	22.4 ±8.6
(Non-Dominant) Left	28.4±9.2	30.8±5.1	20.9 ±5.7	18.4 ±6.5
Percentage (%) of difference	8.1%	15.7	5.1%	17.9 %
p-value	0.008*	0.001*	0.204	0.001*

Table (2). Correlation between dominant (right) and non-dominant (left) isokinetic peak torque of the shoulder joint flexor and extensor muscles

		Left shoulder			
		Flexors		**Extensors**	
Right shoulder (dominant upper extremity)		**180°/sec**	**60°/sec**	**180°/sec**	**60°/sec**
	Flexors r p-value	0.912 0.001	0.578 0.001		
	Extensors r p-value			0.578 0.001*	0.367 0.001*

r: pearson correlation coefficient

IV. Discussion

The strength of the muscles surrounding the shoulder joint is important for joint ROM and stability. Isokinetic devices enable clinicians evaluate strength of various muscle groups and determine which group of muscles require rehabilitation following any injury. The advantages, indications, and efficacy of isokinetic testing and exercise have been well, documented **(23)**.To evaluate muscle strength, usually both sides (dominant and non-dominant are included) with an assumption of bilateral equivalence.

Usually, when testing muscle power in children, one might expect some difficulties compared to testing in adults. This study was planned to include children from 6 to 12 years (all grades in primary school), however based on our experience, it would have been difficult for a six-year old child to follow the instructions given, focus on the tasks required and to understand how the movements are performed normally and with maximum effort. All the previous mentioned factors made it more agreeable to test muscle power within age range of 8-12 years, in the current study.

Previous isokinetic studiesreported various results.Findings in this study confirmed to some extent conclusion by **Cahalan et al. 1991**whomeasured shoulder strength of 50 subjects with the Cybex II dynamometer and reported significant difference in peak muscle torque of shoulder joint flexors and internal rotators in the dominant compared to the non-dominant shoulder joint muscles**(24)**.Similarly, **Lertwanich et al., 2006**reported significant differences of contralateral peak torque in mostmuscles surrounding the shoulder joint (abductors, adductors, extensors, internal and external rotators) except shoulder flexors at both speeds (60 and 180_/sec)**(22)**.This supposedly demonstrates that neuromotor dominance leads to variations in measurements between the left and right UE.

On the other hand, **Ivey et al**. **1985** reported no statistically significant difference between dominant and nondominant isokinetic peak torque of shoulder joint muscles at both slow (60/sec) and fast (180/sec) speeds, despite there was an indication that peak muscle strength was greater in the shoulder joint muscles of the dominant UE**(25)**.**Connelly Maddux et al, 1989** also reported similar results where there was no difference between dominant and non-dominant peak muscle torque of the shoulder joint muscles**(26).**Upper extremity

dominance and regular participation in physical activities, favoring one extremity may result in significant isokinetic strength differences between right and left extremities with bilateral involvement also presenting difficulties in comparisons **(27, 28, 12, 29, 30, 31, 32).**

Correlation between dominant (right) and non-dominant (left) isokinetic peak torque of the shoulder joint flexor muscles proved that there is a connection between the dominant and non-dominant UE in terms of strength, which can be considered as one of the foundations of conduction education where strengthening one extremity will reflect positively on the strength of the other extremity.Findings of this study can be explained by**Hortobagyi et al., 2005** who found that when performed unilaterally, high-force voluntary contractions have been shown to have an acuteand potent effect on the efficacy of neural elements controllingthe exercised limb as well as the opposite, resting limb**(33)**.

V. Conclusion

Physical therapists should not use isokinetic strength of the dominant UE as normativereference baseline data for the dominant extremity, in any situations such as injuries. In addition, it seems a connection exists betweendominant and non-dominant UE in terms of shoulder strength, which means that in clinical settings strengthening of the non-affected UE will reflect on strength of the affected UE.

Declaration of interest

There were no conflicts of interest.

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