



Biomechanical Measurement of Muscle Force on Various Degree of Flexion at Elbow Joint

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Abstract:

Muscles of the elbow joint contributes a lot towards its function i.e., extend and flex the arm to grasp and reach for any object. It also helps to elbow joint movement ranging from 0 degree of elbow extension to 150 degrees of elbow flexion. Therefore, biomechanical analysis through the measurement of muscle force at different degree of flexion is very vital. In this work, we have measure the muscle force at elbow joint flexion of 30°, 45° and 90° respectively. From this study, we also identify the subjects as right hander or left hander. This experiment also clear that the muscle force of men is much higher than women and most of the peoples are right handed.

Keyword: Biomechanical measurement, Elbow joint, Flexion, Joint movement, Muscle force

Introduction:

Measurement of muscle force at elbow joint is of paramount importance because elbow joint performs several activities in different degree of flexion where sufficient muscle force is essential such as weight lifting, pull or push of different objects etc. [1, 2]. There are several instruments and devices available for sports person to determine the muscle force accurately but these systems are not accessible for common people [3, 4]. Furthermore, the testing cost is too high that means the examining procedures are not affordable for economically backward sections [5]. In addition, before entering into various sports such as cricket, Volleyball, Tennis etc., it is imperative to find whether that boy or girl is right handed or left handed [6, 7]. By these measurements trainer can guide them to do the activities as per their strength in the joint muscle [8, 9]. To overcome such limitations, the aim and objective of this work is to design a simple measurement technique using goniometer and load cell that will provide best possible results of muscle force at different flexion position of elbow joint of both the hands [10]. This technique will also helpful to classify the subjects as right hander and/or left hander.

Materials & Methods:

In this present work, a load cell along with a digital strain indicator for muscle strength and a goniometer for joint angle measurement (**Figure-1**).

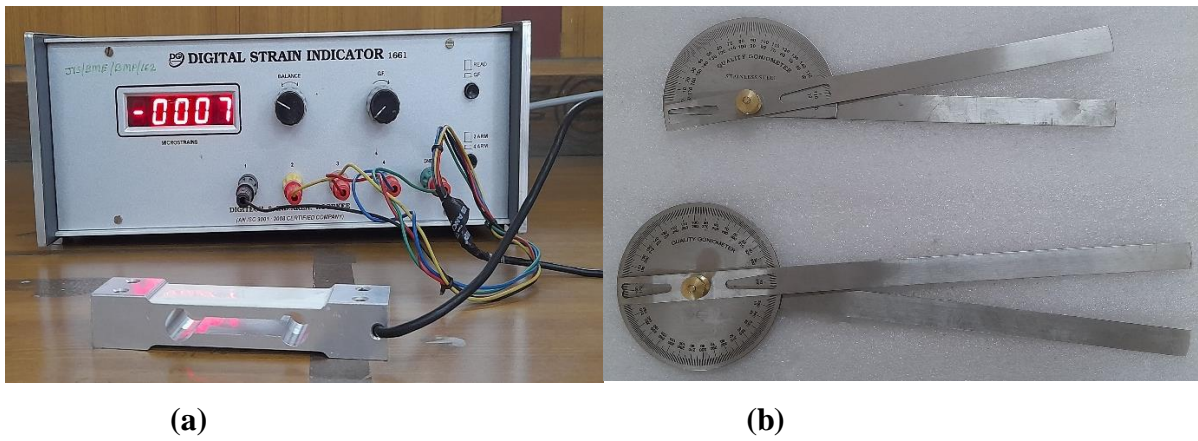


Figure- 1: a) Load Cell with Digital Strain Indicator & b) Goniometer

For, biomechanical analysis of muscle force, 60 numbers of healthy volunteers were included in this study, who were divided into 6 groups based on their age. Each of the volunteer will measure the muscle strength of both the hands using a goniometer followed by a load cell measurement.

The subjects were made comfortable and relaxed. After that, the axis of the Goniometer is placed over the axis of the joint and attached firmly using strap. Muscle force were measured at different degree of elbow joint flexion such as 30° , 45° and 90° respectively. Select a suitable position for starting and use the neutral zero (0) method for measuring and thus recording is commended.

The measurement part should be exposed properly. The stationary arm is positioned to the longitudinal axis of the part proximal to the joint. The movable arm is positioned parallel to the longitudinal axis of the part distal to the joints. The stationary or immovable arm should be positioned accurately in the appropriate place and avoid any sort of trick movement during experiment for accurate measurement. Always the measurements should be taken from the lateral aspect of the part of the joint in order to prevent obstruction. Measurement of the range may be done actively or passively. Established bony marks for measurement. Stabilize the part proximal to the joint to be measured. Experimental set up of and measurement procedure of this work is shown in **figure-2**.





Figure-2: Experimental Setup and Measurement Procedure

Results and Discussions:

Considering the different age groups, we measure the muscle forces for both hands of each subject during flexion at various degree of elbow joint angle i.e., 90° , 45° and 30° respectively. In different age groups, both male and female subjects were considered. All the observed data related to muscle force measurement were recorded and average muscle force for both the hands were calculated for each group. The average muscle force for each group is presented in **Table-1**.

Table-1: Comparison of Muscle force at different degree of flexion of Elbow joint for various age group

Age Group	Joint Angle During Flexion	Average Muscle Force at Right Elbow (N)	Average Muscle Force at Left Elbow (N)
20-25 Years	90°	147-153	98-105
	45°	205-209	159-167
	30°	246-257	197-205
26-30 Years	90°	297-302	153-161
	45°	303-310	198-205
	30°	349-346	244-253
31-35 Years	90°	39-46	43-49
	45°	64-71	88-91
	30°	108-113	238-241
36-40 Years	90°	33-38	31-34
	45°	72-77	51-56
	30°	126-133	104-110

41-45 Years	90°	28-35	62-69
	45°	61-66	97-106
	30°	107-114	155-165
46-50 Years	90°	23-27	50-56
	45°	54-59	94-103
	30°	96-103	141-148

Results obtained from this experiment reveals that muscle strength is more in lesser joint angle during flexion. It also finds out that the people in the age group of 26-30 years having much higher muscle strength compare to other age groups. In most of the group, muscle force of the right hand is far better than the left hand. The results that we received from that experiment have shown a clear distinction between the strengths occupied in both the hands. We also observed that subjects being right-handed can have more strength in their right hand compared to their left hand.

Conclusion:

We have design a reliable procedure to find out the muscle force of elbow joint at various degree of flexion using a simple, low cost goniometer followed by load cell measurement. This experiment design and procedure provides us a clear idea about the muscle force of both the arm during flexion. From this technique we also find out the people of age group 26-30 years having much higher strength in their both the arm compare to other group. From age group 31-35 years to higher age group, the muscle force of both the arm decreases gradually. This experiment also reveals that the muscle force of women is lesser that the men of same age group. Therefore, this simple design procedure would be helpful for the common people and a large section of the people in the society can access and afford this testing procedure as its cost is very nominal.

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