The Relationship of Electromyographic Activation to Isokinetic Muscular Contraction at Different Velocities

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Abstract

Every year athletes creates new world records by breaking the old one. Science contributes lot for creating the new records. Now days athletes are trained very scientifically and systematically to develop each part of the muscles separately. As we know the principle of muscular gradation and their recruitment pattern says that for different task the participation of motor units for each muscle group are different. To determine the muscular contraction and their firing pattern at different contraction of velocities i.e. 60˚,90˚,120˚,150˚ & 180˚. Six students of the Lakshmibai National University of Physical Education, Gwalior were selected as subjects for the study by employing purposive sampling. The age level of the subjects ranged from eighteen to twenty four years. Players had represented inter university level and had no upper extremity injuries or any bone or joint disparities within the past years. The descriptive statistics, correlation coefficient and analysis of variance were applied. The result indicated that both torque and motor unit electrical activity decreased as contractile velocity increase. The relationship between torque generation and integrated electromyographic activity was linear and highly significant.

KEYWORDS: Isokinetic, Electromyography, Motor Unit

Introduction

In modern era science developed isokinetic machines which permits exercise at a controlled rate of muscular contraction; increasing intensity by means of increasing velocity of movement or by increasing the resistance the output of muscles also increases in a respective manner. Thus, for maximal effort gained by the muscles through maximum load being applied within the range of motion. Isokinetic exercise was found to increase muscular torque producing capability at speed equals to training speed or slower than the training speed but not at faster speeds[1].

Muscular contraction is controlled by the CNS, selective activation of fast twitch or slow twitch fibers would have to depend upon unique neurological recruitment patterns, specific to the speed of the intended contraction. If the pattern of muscle activation is exist, then according to the velocity the movement muscle activation should change from slow twitch to fast twitch or vice versa.Komi found that when maximum contractions of the elbow flexors muscles were performed at different constant velocities, the maximum integrated EMG recordings of both biceps brachii and brachioradialis muscle stayed relatively constant at each velocity of contraction[2]. The purpose of this study was to check the electromyographic activation at different movement velocities

Methodology

Participants and Variables

Six students of the Lakshmibai National University of Physical Education, Gwalior were selected as subjects for the study by employing purposive sampling.

The age level of the subjects ranged from eighteen to twenty four years. Players had represented inter university level and had no upper extremity injuries or any bone or joint disparities within the past years. By reviewing the literature and consultation with experts, the research scholar carried out an intensive study and selected major muscles. The Vastus Lateralis Muscles selected as a variable for this study.

Procedure

The data for the selected muscle were obtained with the help of the instrument Bio Thought Technology of Eight Channels. The data were recorded in micro-volt (µv). The skin was prepared by shaving and cleansing to reduce impedance levels (≤10 kΩ). Biometrics SX230 active (Ag/AgCl) bipolar pre-amplified disc electrodes (Gain x 1000; Input impedance >100 MΩ; common mode rejection ratio >96 dB; noise 1-2 µV rms; bandwidth 20-450 Hz) with a 1 cm separation distance were adhered parallel with the muscle fibers, The data were collected of each selected muscles during maximum isometric voluntary contraction. Each subject performed MVIC (Maximum Voluntary Isometric Contraction) to decide the actual activation at different velocities. Before the actual testing, the subjects were given a complete demonstration of each test and the purpose of the test was explained in details. After the demonstration and explanation, electrodes were placed in a proper manner and then subjects were allowed to practice trials in order to get familiarized with the test. On the day of testing each subjects were oriented to the testing protocol. The protocol was sequenced as mentioned below:

1. Warm- up
2. Electrode placement
3. Practice and familiarization
4. Isokinetic Exercise Protocol

Warm-up

Proper time was given to the subjects for general warm-up as well as for specific warm-up to avoid the injury.

Electrode Placement

Site preparation for the electrode – interface included shaving of the area, followed by abrasion using an alcohol soaked pad, rubbing the site of electrode application vigorously. A slight abrasive pad was used. The skin preparation elicits a slight histochemichal effect. Electrodes were placed according to the guidelines of SENIAM and reference electrodes were placed around the table.

Practice and Familiarization

Sufficient practices were given for the better performance, so that they can understand the concept of movement.

Isokinetic Exercise Protocol

All subjects were familiar with the testing technique employed. The exercise device was the cybex Isokonetic dynamometer. Contractile velocities between 0 and 300˚/ sec may be preselected. The subject was seated beside the dynamometer the axis of rotation of the right leg in the line with the axis of the machine. The tibia was aligned in a vertical position so that the angle between femur and knee should be nearby 90˚. The tibia was affixed to the lever arm by a padded support. In addition the trunk was also binded to stabilize. Subject position was similar to that employed by Rodgers and Berger. Starting position for the test was . The termination of the test was at 165˚ of knee extension.

The test velocities selected were 60, 90, 120,150 and 180˚/sec. At each speed the subject was requested to four maximal contraction of the vastus lateralis muscle. All reported measurements represent the mean of the four contractions. The data accumulated provided values for: peak torque, average torque, peak EMG and mean EMG.

Findings

The means and standard deviations for peak and average torque, peak EMG and Integrated EMG at each test velocity are given in the Table-1. Peak values were normalized by expressing all values as a percentage of the highest recorded value obtained, regardless of contraction speed. Most of the time the highest torque values were observed at the slowest test speed (60˚/sec), and therefore, these values usually represent 100 % of peak torque. Comparison of torque production during the series of isokinetic contraction velocities revealed that the vastus lateralis muscles produced the highest peak torque values, as well as the highest average torque values, at the lowest test velocity (60˚/sec). Higher contraction speeds resulted in lower torque values. A peak torque decrement of 53.23% and an average torque decrement of 42.10% were found between the fastest and slowest speeds.

Descriptive Results of Electromyographic and Isokinetic Knee Extension of Vastus Lateralis Muscle

Variables	Contraction Velocity (˚/sec)				
	60˚	90˚	120˚	150˚	180˚
Peak IEMG	96.72	79.28	64.24	57.56	52.12
Average IEMG	98.7	84.47	72.46	62.3	56.76

Total IEMG	90.55	82.16	65.42	30.20	50.48
Peak Torque	98.42	88.56	78.84	69.41	54.32
Average Torque	95.33	86.78	73.21	63.55	51.72

Torque velocity relationships are presented in Figure 1. The integrated EMG output of the vastus lateralis muscle demonstrated a direct inverse relationship to the increasing isokinetic test velocities. Peak integrated EMG decreased 41.94%; average integrated decreased 40.6% Fig 2. This findings suggests an inverse linear relationship between both the peak integrated EMG r = - 0.98% and the average integrated EMG (r = -0.97%) and the contraction velocity. The relationship between peak torque and peak integrated EMG is presented in Figure 3. The data suggest that torque production and motor unit activation are related in a linear fashion (r = 0.95). The relationship between average torque produced during the contraction and average integrated EMG is illustrated in Fig.4. These results indicate a highly significant linear relationship (r = 0.93).

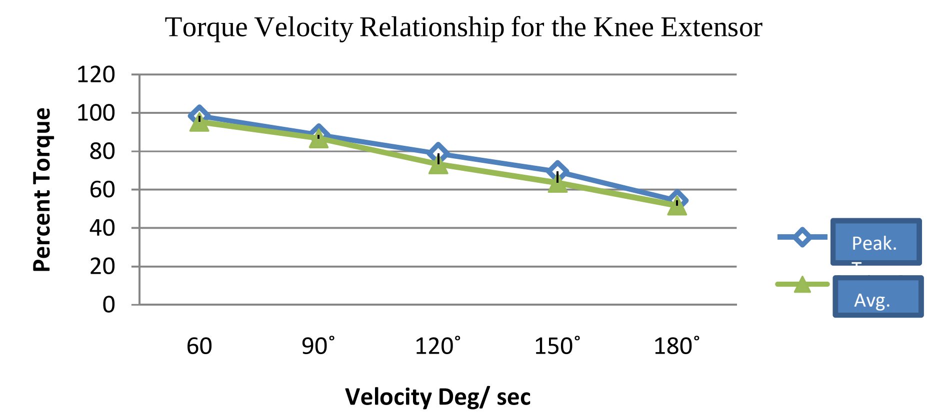

Fig-1

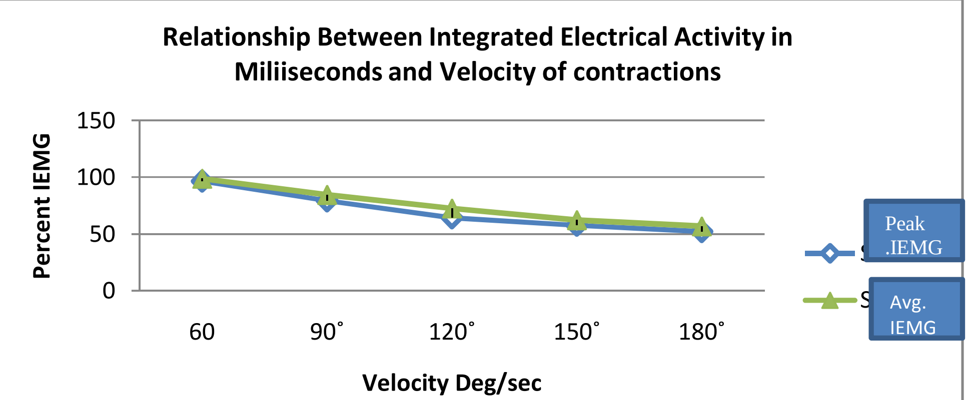

Fig -2

Discussion

Early investigation by Henneman (1968) has suggested a stable, orderly recruitment of motor units in which the smaller, slower contracting units are recruited initially at low force thresholds. As the intensity of contraction increases, larger motor units are recruited, until at maximum all available motor units are activated. If the size principle were true for isokinetic muscular contractions, then the quantity of electrical activity in the muscle might be expected to remain the same regardless of the dynamometer's preselected contractile speed. Because each isokinetic contraction is maximal, all available motor units should be activated regardless of the contractile velocity maintained. The present findings indicate a clearly defined reduction in muscular electrical activity as contractile speeds increase.

Rate coding represents the change in firing frequency of the active motor units, whereas recruitment indicates the total number and type of motor unit activated. Another possible explanation for the apparently greater electrical activation observed during the lower velocity contractions might be the presence of significant agonist-antagonist co contractions. Antagonist activity, were it to exist, might be picked up at the recording electrodes through volume conduction.

The isokinetic loading device allows direct control over contraction velocity. If it were shown that contractions performed at different speeds resulted from the recruitment of certain motor units specifically designed for those speeds, this device would seem to have great potential for specific muscular rehabilitation. Muscular deficiencies occurring at specific contractile speeds might be identified and corrected by having the patient exercise isokinetically at the speeds at which the deficiencies occurred.

Conclusions:

The result of this study revealed significant differences in the total integrated electrical activity of muscles contracting at different speeds. These finding indicates that the differences are due to various gradation of neurological recruitment patterns. It may help in rehabilitation process to develop the specific group of muscles at specific velocities.

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