



INTERNATIONAL JOURNAL OF PHARMACEUTICAL RESEARCH AND BIO-SCIENCE

A STUDY TO ANALYSE THE ISOMETRIC STRENGTH AND ISOKINETIC PEAK TORQUES OF HAMSTRING AND QUADRICEPS AT DIFFERENT ANGLES AND ANGULAR VELOCITY OF KNEE USING ISOKINETIC DEVICE IN NORMAL INDIVIDUALS

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Accepted Date: 18/09/2017; Published Date: 27/10/2017

Abstract: Isokinetic exercise is a dynamic type of resistive exercise with two unique features. First, the angular velocity of an isokinetic exercise device can be specified. Second, when a specified velocity is reached, the device automatically accommodates to give maximal resistance at each [point in the range of motion while allowing the specified velocity to be maintained. The device enables the muscle to exert maximal force at all points in the range of motion. **Objective:** To provide reference data for peak isometric of hamstring and quadriceps at different angle (60°, 90°, 120°) using isokinetic machine. **Method:** The strength of left and right quadriceps and hamstring leg muscle was assessed in fifteen normal individual of BPT students in the campus of SVIMS university, Tirupati, AP in the year of 2016 using a biodex machine. Isokinetic strength was assessed at 60°, 90° and 120° angle of knee flexion. **Results:** Isometric flexion strength was higher in the right leg compared to the left ($P < 0.01$) while there was no significance difference between the 2 legs in extension. Isokinetic strength there was decrease in both extension and flexion strength with increasing velocity. However only in flexion strength is significant right and left difference was observed. In addition, the angle of peak torque decreases with increasing velocity at knee extension but increase at knee flexion. **Conclusion:** It concludes that right side has more power than left side.

Keywords: Isokinetic Study, Device



PAPER-QR CODE

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Access Online On:

www.ijprbs.com

How to Cite This Article:

Shanthi C., IJPRBS, 2017; Volume 6(5): 90-98

INTRODUCTION

In both rehabilitation and sports medicine, accurate measurements of muscle function are required to assess the impact of therapeutic interventions or the effects of physical training. To this aim, isokinetic dynamometry has been introduced in the late 1960s and for more than two decades it has been the standard research tool to investigate muscle function of single muscle groups, more particularly the thigh muscles¹.

Strength is defined as the amount of force a muscle can produce with a single maximal effort.² The dynamic muscle action forms is concentric action (Muscle shortens) whereas (Eccentric action) muscle lengthens and isometric action is no net change in muscle length.

Assessment of muscle strength is a vital component of diagnosing and treating patients in which muscle weakness is present. A variety of methods has been used to test quadriceps strength. The two most common methods used in the clinical testing are manual muscle testing and Isokinetic testing. Manual muscle testing is easier to use, however results are less objective when a person is able to generate high force. On the other hand results of isokinetic measurements were also shown to be highly reproducible.^{3,4} Assessment of muscle strength can be done by various ways such as cable tensiometry, dynamometry, one repetition maximum (1-RM) and computer assisted electro mechanical and isokinetic methods of isokinetic dynamometer. Isokinetics refers to a specific situation in which a muscle or muscle group contracts against a CAR (Controlled Accommodating Resistance), which causes a limb segment to move at a CAV (Constant Angular Velocity) within a prescribed sector of its range of motion.

Isokinetic dynamometry is concerned with the provision of this controlled accommodating resistance and its measurement. During isokinetic testing, besides the physiological and mechanical factors. Psychological factors like motivation and co-operation of the subjects are necessary. In 1950's Hettinger Dynamometer was the first isometric measurement used. In 1967, CYBEX the first isokinetic machine was used in U.S.A. CYCOB, KIN-COM, ORTHOTRON, BIODEX are various other isokinetic devices used. The high muscular imbalance between hamstring and quadriceps is associated with knee and low back injuries. Now a days, isokinetic devices have been extensively used for the assessment and evaluation of muscle function and pathology⁵, rehabilitation⁶, training of muscles^{7,8} and assessment of muscle strength and injury⁹. Increasing the isokinetic speed of contraction will place increasing demands on type II muscle fibers (Fast twitch and fast oxidative glycolytic).

In the clinical setting, it has been used for the evaluation of populations with anterior cruciate ligament deficiency,¹⁰⁻¹³ after reconstruction of anterior cruciate ligaments¹⁴⁻¹⁶ Chronic knee ligament deficiency and partial meniscectomy.¹⁷ Currently,

the availability of combined isometric, concentric and eccentric Isokinetic devices has made it possible for physical therapists and sport medicine physicians to employ combined tests for the evaluation and rehabilitation of patients¹⁸. As a result of the wide range of Isokinetic measurement and the role Isokinetic strength plays in different life settings, the availability of age-related reference values of muscle strength is important not only for patients with impaired locomotor system but also for training programs of healthy individuals¹⁹.

However in India there exists a need for normative data on Isokinetic muscle strength. Therefore, the aim of this study was to provide a reference data for peak isometric and Isokinetic muscle strength of hamstring and quadriceps muscle.

AIM AND OBJECTIVE

To find out isometric strength and isokinetic peak torques of hamstring and quadriceps at different angles and angular velocity of knee using isokinetic device.

MATERIALS

- Anthropometric scale were used to measure the height of the individuals in meters.
- Weighing machine were used to measure the weight of the individuals in kilograms. These two equipment's are used to assess physical variable BMI as kg/m².
- Measurement of muscle strength of Isometric and Isokinetic can be done Bio-dex isokinetic devices.



Basic parts of isokinetic device

- The force acceptance unit: Interface between the subject and the system.
- The lever arm: Converts the force signal into an electrical signal.
- The Load cell: Provides the base for the force acceptance unit about a fixed axis.
- The Head assembly: provides the motor responsible for the motion of the lever arm.
- The Seat or Plinth: Positions the subject with horizontal or vertical alignment options.
- The Control unit: consists of personal computer and its associated peripheral equipment.
- Specific attachments: for various applications of the anatomical joints of the body.

Study subjects

Inclusive criteria

Thirty Normal subjects, 15 males and 15 females between the ages of 20 to 35 years were studied.

Exclusive criteria

- History of any hip, knee or ankle injury pathology or surgery.
- History of any cardiac abnormality.
- Severe neurological & musculo skeletal defects.

Study set up:

College of physiotherapy outpatient departments, SVIMS University, Tirupati, Andhra Pradesh were taken up for the study, **Study period:** Expected study period is 1 year, **Study design:** Observation study.

Statistical analysis: Descriptive statistics were obtained for peak torque during extension and flexion in both legs. Differences between right and left leg strength were tested using t-test. The level of significance was set at 0.05.

Methodology

Subjects were tested for isometric and isokinetic knee extension and flexion strength in both right and left legs. Testing was performed using Biodex isokinetic dynamometer. Maximal isometric strength peak torque will be measured with different angle 45° to 60° . Isokinetic concentric torque will be assessed at 2 angular velocities 60, 180.

Biodex isokinetic resistance accommodates to pain, fatigue and musculoskeletal leverage. The resistance that subjects may encounters is in directly proportion to the efforts executed subjects will be secured during testing by the attachments and isolation straps of the machine.

The system is provided with a computer compatible device that collects displays, stores the data and control the movement of the dynamometal.

Testing protocol

Preparation

The steps of the test were explained for each subject to allow the subject to be oriented and familiar with the testing protocol. Calibration of the unit was performed prior to use according to the manufacturer guidelines.

The subject were seated on the machine chair without shoes, while the thighs and trunk were firmly strapped to the chair at 90° position and with both hands grabbing the handles. The axis

of rotation of the dynamometer was aligned with the anatomical axis of rotation of the knee joint (lateral femoral condyle).

Subjects were tested by Biodex Isokinetic dynamometer at two angular velocities for the knee extensor group during isometric contraction. Arrangement includes testing the subjects, where the resistance pad is placed on a level with the inferior part of the pad immediately above the medial malleolus.

Isokinetic knee strength at 60, and 180 degrees per second were measured with the subject's hips at slightly reclined posterior for about 10 to 15 degrees, and knees flexed 90 degrees.

Apparatus adjustment

Before performing any test on the system, the apparatus was adjusted and set up ready for use. Proper stabilization techniques were applied to restrict motion to the area of interest. Maximal stabilization and minimal stabilization have no significant difference effect on the maximal torque produced by the quadriceps during concentric contraction. Instruct participant to cross arms over chest to minimize involvement of upper body musculature.

Knee testing protocol

A warm up period consisting of riding a bicycle ergometer for 3 minutes. Its prepares the muscles for the demands of testing and prevents injury. Following a warm-up period, the subjects will be introduced to the isokinetic apparatus and the procedures were fully explained.

Procedure

The subject were instructed to hold graph stabilization handles during the test, and fully extend the leg and then flex it as hard & fast as possible (one maximal extension followed immediately by a reciprocal maximal flexion). Each subjects were be given 2 trials followed by 20 seconds of rest. five repetitions were performed at each angular velocity 60, 180 and the highest torque will be recorded. A one minute rest was given before advancing to the next angular velocity.

Table 1: Mean and SD of hamstring and quadriceps peak torque of flexion

VARIABLE	Right LEG	Left LEG	'P' VALUE
	MEAN ± SD	MEAN ± SD	
60	36 ± 8.5	29.4 ± 7.2	< 0.01
90	32.3 ± 7.8	26.1 ± 6.3	< 0.01
120	29.1 ± 6.4	23.5 ± 4.5	< 0.01

INTERPRETATION: The torque of the 60°, 90°, 120° flexion more in right leg then the left leg

Table -2 Mean and SD of hamstring and quadriceps peak torque of extension

VARIABLE	Right leg	Left LEG	'P' VALUE
	MEAN ± SD	MEAN ± SD	
60	56.01 ± 3.94	55.28 ± 4.13	NS
90	45.23 ± 2.99	44.64 ± 2.52	NS
120	41.17 ± 1.81	40.99 ± 2.09	NS

INTERPRETATION: The torque of the 60°, 90°, 120° extension is not significant in both right and left leg.

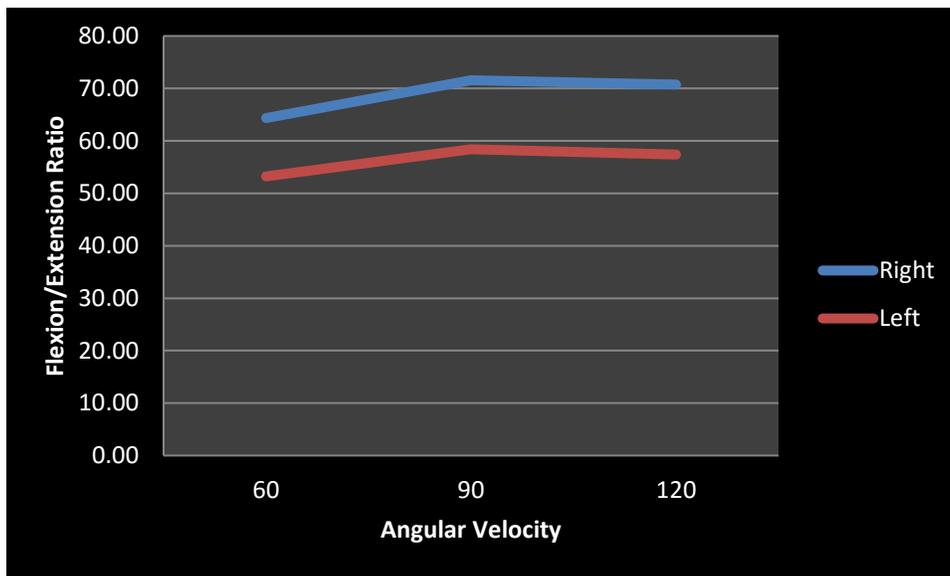


FIGURE 1

DISCUSSION

There is no significant difference between torque for extension of any angle between the two legs. We observed flexion more powerful than right. Extension similar right and left similar study Abdul rahman et al.²⁰ We include right hand individuals study, this may explain right side demonstration high power than left side. Not only strength of the muscle but also texture for fine work like writing buttoning etc more on right side in right hand individuals. It should be interesting to see whether left hand individual would have more power on left side as compare to right side. Further study of this nature should be carried out in left hand individuals. Flexion has power difference interesting noted. Difference between right and left leg is more flexion than extension possible reason would be that greater ROM in flexion than extension more over

use of extensor muscle in standing erect would require both side muscles to be equally strong to prevent imbalances right hand individuals comment walking but flexing the muscle of right lower limb. Because highest strength of right side muscle right side person would prefer weight on right side.

CONCLUSION

Assessment of muscle strength is a vital component of diagnosing and treating patients in which muscle weakness is present. The two most common methods used in the clinical testing are manual muscle testing and Isokinetic testing. Manual muscle testing is easier to use, however results are less objective when a person is able to generate high force. On the other hand results of isokinetic measurements were also shown to be highly reproducible. The right side has more power than left side.

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