ISSN NO. 2320–7418 DOI: 10.22270/jmpas.V10I5.1318

International open access journal

Journal of Medical Pharmaceutical and Allied Sciences

Journal homepage: www.jmpas.com

Research article

Comparison of muscle length in dominant versus non-dominant lower extremity in young asymptomatic individuals

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ABSTRACT

Muscle length is the length where maximum amount of force a muscle is able to produce. This length is determined by the joint angle that corresponds to the muscle. Understanding the optimal muscle length as well as its comparison between the extremities is very important as a part of examination in physiotherapy. Ranges that are obtained of muscle length helps therapist to recognize individuals with reduced flexibility. Identification and knowledge of muscle length has several role including; evaluation of pre-competition risk for injury, decreased flexibility as an predictor of muscle injury and guides in determining interventional strategy plus training program for an individual. Objectives: To compare muscle length of rectus femoris, hamstring's, iliopsoas, gastrocnemius in dominant as well as non-dominant side of young asymptomatic individuals in the age group of 18 to 25 years. Method: Through standard goniometer muscle length data was obtained between dominant, non-dominant lower extremity. The methods of assessment used were; active knee extension (AKE) tests the hamstrings length, Thomas and modified Thomas test had been used to evaluate iliopsoas and rectus femoris while prone, figure-four position accompanied by dorsiflexion utilized for gastrocnemius. Result: Values were calculated using goniometric measurements through the group mean values. There is statistically significant variation between the muscle length of hamstring, rectus femoris, iliopsoas and gastrocnemius between the dominant and non-dominant side ($p<0.05$). Conclusion: Along with data about lower limb muscle length of asymptomatic individuals, we conclude notable difference in dominant to non-dominant extremities muscle length in individuals eighteen to twenty five year.

Keywords: lower extremity muscle length, Modified Thomas test, Active knee extension test, Thomas test, hamstring length, iliopsoas length, gastrocnemius length, rectus femoris length.

Received - 10/07/2021, Reviewed - 29/07/2021, Revised/ Accepted- 02/09/2021

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INTRODUCTION

Length-tension relationship is one of those vital feature considering length-tension relationship, reflecting possible strength in regards with the length of muscle. Important variable in this length-tension relation is ideal muscle length, which is explained as the length of muscle where greatest amount of force can be produced. This is determined by the joint angle squared with optimum muscle length. These optimal angles helps in determining the operational range within the length tension relation when the joint is moved, rotation of tendon takes place. Knowledge about the different aspects of muscle characteristic with regards to the mechanics and physiology has necessary role during surgical interventions where an optimal length will determine efficiency of that surgical process, it guides in designing primary guideline for structuring ergonomics and rehabilitation program which would be maximally beneficial by using the advantages of length-tension relationship for an individual muscle [1].

Flexibility is characterized by an ability to mobilize one or multiple joints across range of movement in order to perform specified motor action. The two essential metrics, power or strength and flexibility plays a role in physical activity performance in relation to dominant and non-dominant limb, bringing off asymmetrical movement patterns like kicking a ball or shifting speed and directions. Different factors do influence the predication of any injury; hence proper clinical evaluation is needs to be tuned in along with tests application [2].

Flexibility and muscle length being a part of assessment is commonly tested by physiotherapist in patient suffering from musculoskeletal disorders. Through adjacent range of joint motion, lower extremity length is calculated. Further the length is evaluated on the basis of data obtained after performing tests on both the lower limb and lastly its comparison with opposite extremity. Identification of muscle length with their differences helps us to understand whether a person who is examined will need any intervention targeting specific group of muscle or the joints. The ranges that are obtained of muscle length helps therapist to recognize individuals with reduced flexibility. Reduced flexibility connects with an occurrence of painful event or say injury to muscle [3].

Flexibility forms an important component in relation to performance and health related fitness. Ample amount of flexibility have been shown to have linked with improved quality of life [4]. Number of factors might contribute to the flexibility such as age, gender, size of muscle and exercise. Males are lesser flexible than females, with differences mainly attributed to the anatomical structures [5].

One of the major properties of healthier muscle tissue is its ability to lengthen or extensibility. Normally muscle extensibility is the one where in full synchronized physiologic pattern of movement across all joint can be performed by the muscle in such a direction that could lead to separation of insertion and origin maximally from each other. But when this extensibility is reduced motion gets impeded. Muscle losing its extensibility lands up to various alterations of muscle functioning and subsequently locomotor system. Postural muscles are extremely prone to tightness and it can further promote cascade of eventful changes. Patient's insight about tightness is frequently reliable indicator for tightness, moreover examiner's feeling of end-feel, proper positioning of subject forms the baseline for evaluation along with this, to amplify correctness of testing; comparison of the results in follow-up examination with standardization and precision during procedure is followed. proper positioning and an initial assessment forms a basis for testing length of muscle without getting an error in the measurements especially when there is presence of tightness in some or the other muscle group [6-9].

Identification and knowledge of muscle length is very important as it has several beneficial role in an individual's life including, evaluation of pre-competition risk for injury in an athlete, testing the flexibility of muscle since decreased flexibility is commonly resulting into muscle injury. Basically joint angle corresponding to muscle determines the muscle length but if by any cause range of motion at particular joint is decreased then it ultimately reduces the amount of flexibility available at the specified joint and hence can predispose an individual towards injury. Length and flexibility assessment helps the physiotherapist to gain an idea about the muscle function and at times in some condition work as an indicator for those individuals who might be in future gets predispose to certain type of injury due to the lack of flexibility, reduced muscle length [10][11].

Muscle length testing allows clinician the ability to find out impairments that could assist into determining most appropriate interventional strategies and training programs. Moreover, muscle length as an outcome can address amongst asymptomatic individuals participating in any exercise or sports activity. Hamstring and rectus femoris tightness have been linked to musculoskeletal injuries in the lower extremity. Reduced flexibility of both of this muscle group has been linked to isolated muscle injury, low back pain, patellar tendinitis and patellofemoral pain syndrome adolescents as well as adults [12][13].

There are many tests that can be used to evaluate muscle length. Researchers have evaluated techniques that are effective, ensuring that the tests are easier while performing, has high intra-rater with interrater reliability and also they are commonly implemented tests in routine examination. The literature on muscle length testing revealed that range of motion either active or passive or weight bearing technique can all be used to measure gastrocnemius muscle length, however because of simplicity, lowered risk of bias amongst researchers and ease in the standardization with reliability, active dorsiflexion test was selected for determining gastrocnemius length. The active knee extension test is standard and accurate way of determining the hamstring muscle group length. Reliability for Active knee extension test has strong suit both inter rater and intra-rater for measurement of hamstring muscle group, while achieving stabilization of hip and pelvis. Mild detectable change contemplated as veracious change in an asymptomatic adult individuals. The Thomas test was used to examine the iliopsoas for measuring its length, this test is generally recognized and widely used clinical test. The rectus femoris length was estimated availing modified Thomas test which is well known and dependable test [12][14][15].

There was need for this study because of paucity in the studies which evaluates muscle length in asymptomatic individuals and whether there is any difference in dominant to non-dominant side. The objectives of the study were to compare muscle length of Iliopsoas, Hamstring, Gastrocnemius, Rectus femoris from dominant to non-dominant extremity of young asymptomatic individuals.

METHODOLGY

This study was accomplished in Datta Meghe Institute of Medical Sciences. It was an observational study wherein three hundred students participated through random sampling method out of which one hundred eighty were females and one hundred twenty were males. Mean age of all subjects was 21.66 ± 2.37(18-25yrs) and mean height was 163.40 ± 10.23 (see table 1).This research was approved from an

institutional ethical committee and all the subjects had signed an informed consent before they had their participation in our study. Protocol regarding the publication of these original study was well defined earlier [16]. The inclusion criteria included individuals willing to participate and the individuals between ages of 18 to 25. The exclusion criteria included former surgical interventions performed over lower extremity or lower back, fresh injury or pathological condition of lower limbs or low back (past 3 months), certain medications or consumption of substances that could change functions related to sympathetic system and no elite athletes were accepted.

Table 1. Distribution of patients according to their age in years

Age in years	No of patients	Percentage
18-20	106	35.33
21-23	106	35.33
24-26	88	29.33
Total	300	100
Mean±SD	21.66±2.37(18-25 years)	

Standard goniometer was used to rule out length. The use of goniometric calculation have shown to be accurate without forming intra rater reliability [3]. Several tests were inculcated to measure the length of respective four muscles. Gastrocnemius length was determined in prone, figure of four position followed with dorsiflexion. Although there are numerous way for testing, but the position here used was for its simplicity, intra rater reliability and less bias. Active knee extension test was been utilize to length of hamstring. This test shows excellent inter-rater reliability with interclass coefficient (ICC) values as such 0.87 and 0.81[3][17]. Modified Thomas and the Thomas test evaluated the length of rectus femoris and iliopsoas respectively. Thomas test has wide acceptance as a clinical test and shows interrater reliability of 0.60. High correlation has been obtained in a study about usage of goniometer with Modified Thomas test showing interrater reliability 0.91 to 0.93 [3][18][19].

Data measurement

Age, gender, height, weight, past medical history and surgical history was recorded before the start of study with the help of questionnaire. Leg dominance was acquired by asking that subject 'what would be their favored leg if asked to kick a football'. Measurement of four muscles was done from distal towards proximity, right leg muscles length was measured before the left. When assessing the range of motion, standardization has been advocated for ensuring reliability and decreasing errors.

The individual was measured in prone, figure-four attitude for gastrocnemius. The measuring feet was hanged at boundary of couch. This maintains the neutral position of that lower extremity. Center of goniometer was placed inferiorly over surface of lateral malleolus, static arm was kept parallel to lateral border of fibula, moving arm was lined with sidelong midline of calcaneum. Subject was instructed to perform Dorsiflexion of ankle actively until sort of stretch was felt in gastrocnemius. Lastly range of dorsiflexion was measured.

Length of hamstring was evaluated via active knee extension test where the subject was lying supine unmeasured hip was strapped downward for stabilization. Then knee was flexed to 90 as an initiation point of reference. Pivot of goniometer positioned laterally over the knee taking into account midline of joint line; unmovable arm kept parallel to femoral shaft, moving arm straightened with fibular shaft, lined with malleolus (lateral). Then the subject had performed knee extension till point of stretch is reached. At the same point, knee's angle was calculated.

For measuring Rectus femoris muscle, test used was modified Thomas. Initially subject stood at couch`s end, holding opposite side knee towards chest region, by clasping with both the hands, subject progressed to lie over table while measuring extremity hanged off. Goniometer's fulcrum was retained on lateral condyle (femur), fixed arm over the lateral femur coinciding with greater trochanter, movement arm with lateral part of tibia. Knee flexion was measured.

Iliopsoas length was measured with the help of Thomas test. Subject was taken into supine position with the foot hanging out couch. Then are told to pull in opposite extremity towards the chest much as possible so as to flatten the lumbar spine on table. On greater trochanter fulcrum was placed, stationary arm aligned with truncal midline and mobile arm bounded to lateral aspect of thigh, lined upto lateral condyle of femur.

RESULTS

Majority of the subjects had right leg dominance (94%) while remaining had shown left leg dominance (6%). Data obtained from all the four muscles was separated into dominant and non-dominant leg. Table 2 illustrates comparison between mean and standard deviation of dominant versus non dominant leg. Descriptive, inferential statistics using z-test was used for statistical analysis. Software used to analyze was SPSS 27.0 version and $p<0.05$ is considered as level of significance. Based upon result achieved, there is statistical significant difference in the muscle length between lower extremities. Figure one shows us the differences in muscle length.

Figure 1. Showing muscle length of all four muscles

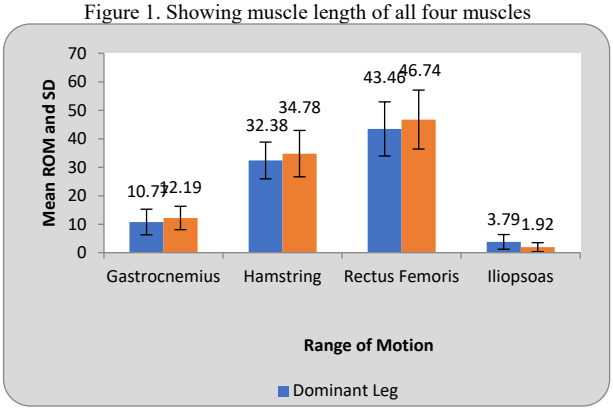

Table 2. Comparison of Range of motion (ROM) in dominant with non-dominant leg

mean±SD	Dominant Leg	Non Dominant Leg	z-value	p-value
Gastrocnemius	10.77±4.50	12.19±4.10	4.02	0.0001,S
Hamstring	32.38±6.45	34.78±8.15	3.99	0.0001,S
Rectus Femoris	43.46±9.50	46.74±10.35	4.04	0.0001,S
Iliopsoas	3.79±2.58	1.92±1.60	10.63	0.0001,S

DISCUSSION

On the basis of results that are obtained, a set of results is confirmed regarding lower extremity muscle length of asymptomatic individuals of age 18-25 years. In this study, findings of gastrocnemius are 10.77± 4.50 (dominant leg), 12.19 ± 4.10 (non-dominant leg). Mosley et al. (2001) in his study found the value 18.1 ± 6.9^0passive dorsiflexion in two hundred ninety eight subjects between the age group of fifteen to thirty four years. Corkery et al (2007) established normative data for collegiate students of 18 to 22 years wherein mean was 5.1 ± 5 for right leg (dominant) and 3.7 ± 4.6 (non-dominant leg). Parikh et al (2015) who provided reference values for muscle length in elite players has shown mean with 13.39 ± 2.09 (in dominant) while 13.99 ± 2.37 (in non-dominant). Soperet al (2004) analysed that passive dorsiflexion make use of application of pressure which affects the range and the final range obtained would be more, due to stretch beyond point. Finally the values generated would be more. So we have used active dorsiflexion.[3,5,20–22]

The results of hamstring length were 32.38 ± 6.45 for dominant limb and 34.78 ± 8.15 for non-dominant limb in this study. Corkery et al(2007) measured 72 individuals of college aging between eighteen to twenty two years has discovered values as such 26.8 ± 13.3(right)and 29.8 ± 13.4 (left). Parikh et al (2015) studied muscle length in elite cricketers where he obtained data as 27.64 ± 5.66 for right extremity and 25.72 ± 5.21 for left one. Muhammed et al(2018) had stated active knee extension angle more than thirty three degrees for men's and more than 23.4 degrees for women's. Active knee extension was used because of its excellent reliability [3,20,23].

Mean values for rectus femoris in study was 43.46 ± 9.50 for dominant limb while 46.74 ± 10.35 for non-dominant. Harvey et al(1998) when evaluated length of elite athletes using modified thomas test had stated values as 52.5 ± 7.56, which is similar to findings of corkery (2007). Parikh (2015) had given length values in cricketers as 55.63 ± 6.33 (dominant), 55.10 ± 6.83 (non-dominant). Hamstring length is hamstring injury predictor [3,10,20].

Data obtained in our study for iliopsoas is 3.79 ± 2.58 for dominant one and 1.92 ± 1.60 for non-dominant extremity. Wang et al in 1993 did not recognize any difference in iliopsoas length of extremities. Krivickas (1996) made use of Thomas test over athletic collegiate and hip flexion angle was 6 ± 7^0 (male) and 1 ± 3^0 in females. Parikh et al (2015) in his study of muscle length in elite players discovered data as 4.94 ± 1.03(dominant) and 3.88 ± 0.99 (non-dominant) [5,12,16].

We found remarkable difference in the length of iliopsoas, gastrocnemius, rectus femoris and hamstrings. Although the study is carried on large number of individuals, age group was confined, which can be increased, like whether aging has an impact on muscle length and what data varies with age. Secondly, measurement errors to be addressed emphasizing goniometric reliability for specifically assessing muscle length needs to be deeply studied. Even several techniques can be compared or discovered to get muscle length data.

CONCLUSION

These data has provided set of details for lower extremity muscle length and had shown significant difference between the length of gastrocnemius, rectus femoris, iliopsoas and hamstring muscle between dominant and non-dominant lower extremity of asymptomatic individuals

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How to cite this article

Anushree P, Pratik P, Om C. W, Sakshi P. A, Waqar M. N, 2021. “Comparison of Muscle Length in Dominant Versus Non-Dominant Lower Extremity in Young Asymptomatic Individuals”. Jour. of Med. P’ceutical & Allied. Sci. V 10 - I 5, 1318, P-3569-3573. doi: 10.22270/jmpas.V10I5.1318.