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Comparison of Four Clinical Test for Assessing Hamstring Muscle Length

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Abstract--- Objective: *To compare the four clinical tests for assessing hamstring muscle length.*

Need For the Study: *Muscle tightness make the musculotendinuous unit more susceptible to injury1. It leads to posterior pelvic tilt, reduced lumbar lordosis and causes low back pain2. Hence, assessment of hamstring muscle length is important.*

Setting: *Women's Health Professional Hostel, Annamalai University.*

Study Design: *Double blind analytical study*

Study Population: *50 subjects with age group ranging from 18-25 years volunteered to participate in this study.*

Selection Criteria: *Screening of all subjects to ensure that tripod sign positive.*

The participants will be selected with normal Body mass Index (18.5 to 24.9 kg/m2)

The subjects who had no history of Orthopaedic or Neurological disorders.

Materials:

Plinth

Cloth straps

Goniometer

Tape measure

Weighing Machine.

Method: *Four tests were assigned randomly to the four independent physiotherapist who were doing B.P.T internship. Right lower extremity will be selected to perform the test.*

The four tests are:

Straight Leg Raise (Stabilization Strap) test

Straight Leg Raise (Low Back Flat) test

Active Knee Extension test

Passive Knee Extension test.

Data were collected from four physiotherapists and statistically analyzed.

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Result: *From the collected data, it shows that significant differences exists between SLR-SS, SLR-LBF mean difference (3.5) and P<0.05.Similarly in AKE, PKE mean difference (6.7) and P<0.05. All the four are highly correlated(r>0.5).*

Conclusion: *Hence, it was concluded that significant relationship exists between all four tests. Both AKE and PKE are useful and alternative to SLR-SS and SLR-LBF.*

Keywords--- *Hamstring Muscles, AKE and PKE, Physiotherapist.*

I. INTRODUCTION

Hamstring muscles are three large muscles namely semitendinosus, semimembranosus and biceps femoris located in the posterior aspect of thigh. Its primary action are to extend the hip and flex the knee[3]. This muscle group spans the hip and knee joint from a common source of pelvic girdle; the ischial tuberosity, and is intricately involved in both locomotion and stability of the lower extremity[4].

A surprising number of problem arise from tight hamstrings. The problems stated by Liemohn as lack of hamstring flexibility may be a predisposing factor of hamstring muscle strain[5], and make a musculotendinuous unit more susceptible to injury, poor posture. By pulling the hamstring muscle leads to posterior pelvic tilt, reduced lumbar lordosis and causes Low back pain.

Objective measurement of hamstring muscle length are needed to quantify baseline limitations and to document the effectiveness of therapeutic interventions both with patients and with healthy people. A number of hamstring muscle length tests have been used previously but validity and reliability have been raised for some procedures. In sit and reach test many author contend that anthropometric factors such as disproportionate length of the limb in relative to trunk, scapular abduction and spinal mobility may influence the results[6]. Hopkins and Hoeger modified the test, modified sit and reach test to control for scapular abduction and this seemingly improved reliability[7]. In toe-touch, test spinal mobility and pelvic rotation may influence hamstring extensibility during forward bending, it is not a reliable method8. SLR, AKE, PKE was used to assess hamstring muscle length. The reliability of these tests was good. Hamstring muscle length is measured indirectly by angular measurement of unilateral hip flexion with knee extended (SLR) and unilateral knee extension with the hip flexed to 90 degree (AKE & PKE) [11, 12]. Although SLR may influence by structures other than hamstring. It has a dual function measuring hamstring length and sciatic nerve mobility[7]. The PKE is similar to AKE except the therapist extend the knee passively until the resistance felt.

The purpose of this study was to compare the hip flexion angle of SLR-SS with the hip flexion angle of SLR-LBF and to compare the knee extension angle of AKE with knee extension angle of PKE.

II. REVIEW OF LITERATURE

RICHARD et al.[13] In this study four test were compared to measure hamstring length. The hamstring length was assessed by Straight leg raise – Stabilization strap (SLR-SS), Straight leg raise-Low back flat (SLR-LBF), Active knee extension (AKE), Passive knee extension (PKE). The right limb of thirty men were selected with age group ranging from 18-40 years. The result shows that no significant difference between angles of SLR-SS, SLR-LBF.

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Whereas AKE, PKE were significantly different. Significant relationship were found among four tests.

FISH et al.[14] The aim of this study was to comparison of three different methods for the measurement hamstring flexibility. A Parametric comparative experimental research design is utilized. Forty female subjects with the mean age of 21.29 years were selected. The methods are Straight leg raise, Active knee extension, and Passive knee extension method. The result of this study indicated significant differences between hamstring muscle lengths.

Youdas et al.[15] The aim of this study to examine the factors of genders and age on hamstring muscle length measured by Passive straight leg raise(PSLR) and Popliteal angle(PA). Two hundred and fifteen adults (108 women, 106 women) with age range of 20-79 years. A cross-sectional descriptive study was used. The result showed that hamstring muscle length differed significantly between genders for both methods of measurement, with the female demonstrating greater flexibility than males.

NORRIS et al.[16] The purpose of this study was to assess the inter-tester reliability of two testers using a novel lf monitored active knee extension test in the clinic setting with 20 normal subjects of 20-24 years. The subject monitored the position of the right femur manually and kept it in 90 degrees flexion throughout the test. The result of this study is that AKE test when used in conjunction with goniometry accurate surface marking, and manual monitoring of the test leg is a reliable measure of hamstring muscle length.

FREDRIKSEN et al.[12] The aim of this study was to determine the reliability of a test designed to measure length of the hamstring muscles and to assess pelvic rotation. The knee was passively extended by a standardized force, while the hip was stabilized in 90 degrees of flexion. Twenty-eight test-retests were performed. The correlation coefficient was found to be 0.99. It is concluded that the passive knee extension is a simple and reliable method to measure hamstring length and the associated pelvic rotation is minimal recommend that knee extension angle test as the gold standard measure for hamstring muscle length.

RAKOS et al.[17]This study evaluated the interrater reliability of the Active knee extension test (AKET) to measure hamstring length with 101 subjects with age group ranging from 10-13 years. The AKET was performed with subjects lying supine with hip flexed to 90 degrees. The result of this study suggest that AKET demonstrates good interrater reliability to measure hamstring length.

QUINN et al.[18]The purpose of this study was to examine the concurrent validity of four clinical tests used to measure hamstring muscle. A pilot study was conducted to determine the intratester reliability of four hamstring length measures: knee extension angle (KEA), Sacral angle (SA), Straight leg raise (SLR), and Sit and reach (SR). Eighty-one subjects (42men and 39 women) participated. Based on the result of this investigation and a review of literature, the author recommend that Knee extension angle test as the gold standard measure for hamstring length.

FAKHARI et al.[19]The aim of this study is to find the relationship between PKE and SLR measurement of hamstring length. 3308 healthy girls with age group ranging from 3-17 years were tested. During SLR, pelvic movement can contribute to the angle of SLR, while pelvic movement in PKE is limited. Result demonstrated that significant relationship between two tests. But PKE test may be useful alternative in comparison with active SLR for providing an indication of hamstring muscle length.

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DENISE et al.[20]This study was conducted to determine the relationship between two alternative tests for indicating hamstring musculotendinous length, active knee extension (AKE) and active straight leg raise (ASLR). Twenty-three healthy subjects were tested. There was a significant relationship between AKE and ASLR. They concluded that both AKE and ASLR tests claim to provide an indication of same basic phenomenon presumably hamstring muscle length. For this reason, the AKE test may be a useful alternative to the straight leg raise test for providing an indication of hamstring muscle length.

LISA et al.[21]They investigated whether there was a difference in hamstring length between patients with patellofemoral pain syndrome and healthy asymptomatic control aged between 18 to 35 years. The outcome measure used is that to measure hamstring length is passive knee extension method. This study found that patient with patellofemoral pain have a shorter muscle than asymptomatic control.

SARAH B et al.[22] The aim of this study was to investigate the relationship between hamstring flexibility between and pelvic rotation during forward bending. 20 asymptomatic subjects performed forward bending in a touch-the-toes motion. A passive SLR test was used to assess hamstring flexibility. They found that hamstring influence pelvic rotation during forward bending in healthy individuals, decrease flexibility was observed with limited rotation.

NORRIS et al.[23]The purpose of this was to determine if an association exist between hamstring muscle length and the angle of pelvic tilt during forward bending in a student sporting population. The active knee extension method is used to assess hamstring muscle length. The result suggest that no association exists between hamstring muscle length and total angle of pelvic tilt in people with extensibility of hamstring muscle with in normal limits.

MICHAEL et al.[5]This study is to compare the effectiveness of two types of treatment of hamstring muscle strains. Twenty subjects (18 male and 2 female) all with hamstring strains, participated in the study. Hamstring muscle length is measured by the amount of passive knee extension with the ipsilateral hip joint positioned at 90 degreesof hip flexion. The result of this study suggest a relationship between sacroiliac joint dysfunction and hamstring muscle strain.

ANDREW ROLLS et al.[7]The purpose of this study is to determine the relationship between hamstring muscle injury and hamstring length in prospective analysis of adolescent football players. The hamstring muscle length was assess through modified sit and reach test, SLR, AKE, PKE & SKE. The result showed that data for all hamstring muscle length tests were not significantly different injured and non-injured legs. However, estimates of apparent hamstring muscle length differ dependent on age and on test employed.

SCOTT et al.[24] The purpose of this study was to measure the duration of maintained hamstring flexibility after a one-time, modified hold relax stretching protocol. Thirty male subjects with limited hamstring flexibility in the right lower extremity were randomly assigned to a control group and an experimental group. AKE is used to measure hamstring flexibility. They concluded that a sequence of five modified hold-relax stretches produced significantly increased hamstring flexibility.

MOHDWASEEM et al.[25]The purpose of this study was to investigate the effectiveness of muscle energy

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technique on hamstring flexibility.20 healthy subjects of male with hamstring tightness were randomly assigned as two groups. Hamstring length was measured using the active knee extension method. The result concluded that muscle energy technique is significantly improving hamstring flexibility.

III. METHODOLOGY

Setting

Women's Health Professional Hostel Annamalai University.

Inclusion Criteria

50 normal subjects with hamstring tightness on right side.

Age: 18-25

BMI: Normal BMI (18-24.9kg/m2)26

Sex: Female

Materials

Tape measure

Cloth straps

Weighing machine

Plinth

Pillows

Universal goniometer

Tripod Sign

The examiner asks the patient to sit on the side of the examining table with the knees bent to 90 degrees. The examiner then grasps the patient ankle on the side to be tested and extend the knee fully. A normal patient should be able to allow the knee to be fully extended and yet remain seated upright. In the patient with hamstring tightness, passive extension of the knee results in involuntary extension of ipsilateral hip. This involuntary hip extensor causes the patients trunk to fall backward, often to the point that the patient will need to support himself or herself without stretched hands[27].

Method

1. SLR - (SS)TEST
2. SLR - (LBF)TEST
3. AKE TEST
4. PKE TEST

Procedure

Straight Leg Raise (Stabilization Strap) Test

The subject was positioned supine and cloth straps was secured over the anterior superior iliac spines of the

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pelvis and across the mid-thigh of left lower extremity. The examiner elevated the right lower extremity with her right hand until firm resistance was felt. The axis of the goniometer was placed on the lateral aspect of the hip joint, with the stable arm along the mid axillary line and the movable arm following the line of femur. The measurement was taken.

Straight Leg Raise (Low Back Flat) Test

To maintain the low back flat an appropriate number of pillows placed under the left thigh. The examiner elevated the right lower extremity until firm resistance was felt. The examiner closely monitored the knee to ensure that full knee extension was maintained during the test. The goniometric measurement was taken as described above.

Active Knee Extension Test

The subject actively maintained his right hip at 90 degrees of flexion. The subject was then instructed to actively extend the right knee. The goniometric axis was placed on the lateral aspect of knee joint. The stable arm parallel to femur and the movable arm parallel to fibula. The goniometric measurement was taken.

Passive Knee Extension Test

The examiner maintained the right hip at 90 degrees of flexion with her left hand and moves the right knee through extension with her right hand placed over the distal posterior surface of the leg. The goniometric measurement was taken as described above.

IV. STATISTICAL ANALYSIS

For the purpose of comparison of four clinical test for assessing hamstring muscle length, the data have been collected on SLR-SS, SLR-LBF, AKE, and PKE from 50 respondents. The trial have been repeated three times and average values computed.

Table 1: Mean and Standard Deviation for Their Age, Height, Weight and BMI

Group	*N*	*Mean*	*SD*
AGE	50	20.6	-1.94
HEIGHT	50	157.72	-6.71
WEIGHT	50	54.48	-5.39
BMI	50	21.85	-1.45

The mean and standard deviation for the subjects age was 20.60+-1.94 years and height was 157.72+-6.71 cm and weight was 54.48+- 5.39 kg and BMI was 21.85+- 1.45 kg/m^2

Table 2: The Mean and Standard Deviation for their SLR-SS, SLR-LBF, AKE, and PKE

Group	*N*	*Mean*	*SD*
SLR-SS	50	70.26	4.45
SLR-LBF	50	73.77	3.96
AKE	50	155.6	5.51
PKE	50	162.32	5.24

The mean of the hamstring muscle length was tested using SLR-SS are 70.26+- 4.45and SLR-LBF are 73.77+-3.96 and AKE are 155.60 +-5.51 and PKE are 162.32+-5.24.

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Table 3: Pearson`s Correlation Matrix

Tests	*SLR-SS*	*SLR-LBF*	*AKE*	*PKE*
SLR-SS	1.000	0.961	0.725	0.757
SLR-LBF	0.961	1.000	0.725	0.755
AKE	0.725	0.725	1.000	0.863
PKE	0.757	0.755	0.863	1.000

'r' greater than .5, Pless than 0.01

The above table shows that correlation 'r' value among the four tests for hamstring muscle length. The correlation r for SLR-SS and SLR-LBF was 0.961, AKE and PKE was 0.863,SLR-SS and AKE was 0.725,SLR-LBF and AKE was 0.725, SLR-SS and PKE was 0.757 and SLR-LBF and PKE was 0.755. It was evident that there exists highly positive correlation among all the four tests with 'r' value greater than .5 ($r > .5$) and p value 0.0001 ($P < 0.01$) which was highly significant.

Among the four tests, the SLR-SS and SLR-LBF measures the angle from 0-90 and AKE and PKE measures the hamstring muscle length from 90-180. The former two tests and the latter two test were separately compared using the paired `t' test to draw the results.

Table 4: Comparison of SLR-SS and SLR-LBF Using Paired `T' Test

Groups	*N*	*Mean*	*SD*	*`T 'value*	*`P 'value*
SLR-SS	50	70.26	4.45	19.65	0.01
SLR-LBF	50	73.77	3.96		

From the above table it was found that using the Paired 't' test the obtained t value was 19.65 and p value was0.01 which was found to be highly significant at 5% level of significance ($p<0.05$). Hence the mean differ significantly.

Table 5: Comparison of AKE and PKE Using Paired t Test

Groups	*N*	*Mean*	*SD*	*`T 'value*	*`P 'value*
AKE	50	155.60	5.51	16.88	0.01
PKE	50	162.35	5.24		

From the above table it was found that using the paired 't' test the obtained t value was 16.88 and p value 0.01, which was found to be highly significant at 5% level of significance ($P < 0.05$). Hence the mean differ significantly.

V. RESULT

From the obtained data it shows that the Pearson correlation coefficient for all the four test gives ($r<0.5$) hence the four test were highly correlated. The paired t test was used to compare the SLR-SS and SLR-LBF gives mean difference 3.5, with the corresponding t value 19.651 and p value 0.01 ($p<0.05$) and the mean differ significantly. The paired t test for AKE and PKE gives mean difference 6.7 and the corresponding t value 16.88 p value 0.01 ($P<0.05$). Hence the mean differ significantly.

VI. DISCUSSION

50 healthy subjects were selected for this study according to the selection criteria. The mean and standard deviation for their age, height, mass are 20.60+-1.94 years, 157.72+-6.71cm, 54.48+-5.39kg respectively. To avoid gender difference and for our convenience the female subjects were chosen.

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A double blind study is a scientific experiment, it prevent the conscious and unconscious bias on their part gives an accurate idea and validating the results. In this study, neither the subjects nor the therapists know what was the purpose of this study.

Four Physiotherapist Internship students were randomly selected as the testers. A brief explanation and demonstration was given to the therapist regarding the testing procedure (SLR-SS, SLR-LBF,AKE,PKE).

The findings of mean difference between SLR-SS and SLR-LBF was 3.5 and $P<0.05$. This shows that they were significantly different. The Stabilization strap across the ASIS probably helped to secure the pelvis and the low back may have been flat during SLR-SS. This could partially explains the similarity of two tests. However, in SLR-LBF the use of pillow on the contralateral thigh could increase a minimal degree when compare with SLR-SS. Similarly the mean difference between AKE and PKE was 6.7 and $p<0.05$. This shows that they were significantly different. A possible explanation of this difference is that AKE may represent a measurement of initial length (unstretched length) and PKE may represent maximal length(stretched length). The AKE test requires the subject to extend the knee beyond the point of initial resistance that stimulates myoclonus. Slight flexion of the knee to the point of myoclonus appears to return the muscle to a point of initial length. The testers may applied more stretch force in PKE will increase a knee extension degree when compare with AKE. Therefore, the PKE test however probably lengthens the muscles closer to a point of maximal length. This correlates well with this study conducted by RICHARD L[13] and S J FISH[14].

When correlating the four test shows significant highly positive correlation ($r>.5$) obtained. It suggests that all tests are providing an indication of same basic phenomenon, presumably hamstring muscle length.

From the above analysis all the four test were correlated positively, but there is a significant differences exists between SLR-SS,SLR-LBF(3.5) and there is also a difference exists between when compare with AKE,PKE (6.7).

VII. RECOMMENDATIONS

This study was further enhanced by:

1. Increasing the sample population
2. Both genders can be included
3. Bilateral hamstring length can be assessed.

VIII. CONCLUSION

Highly positive correlation exists between all the four tests. Both AKE and PKE are useful and alternative to SLR-SS and SLR-LBF.

IX. ABBREVIATIONS

BMI: Body Mass Index; **AK**E-Active Knee Extension; **PKE** – Passive Knee Extension; **SLR-SS** –Straight Leg Raise Stabilization Strap; **SLR-LBF** -Straight Leg Raise Low Back Flat

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