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## INFLUENCE OF SEQUENCE OF JOINT MOVEMENT ON HAMSTRING LENGTH TEST RESULTS

\*<sup>1</sup>Dinesh Sorani<sup>2</sup>Sheshna Rathod

## ABSTRACT

**Background:** Hamstring length assessment has an important value in Physiotherapy assessment and better outcome of patients. Purpose of the study was 1) To compare Active SLR and Active knee extension test values as per Kendall's muscle-range assessment, 2) To compare Passive SLR and Passive knee extension test values as per Kendall's muscle range assessment

**Method:** Total 100 healthy individuals (age  $20.83 \pm 1.17$ , 14 males, 86 females) participated in study. Goniometric assessment of hip flexion-extension and knee flexion was assessed followed by active and passive straight leg raising (ASLR and PSLR) and knee extension tests (AKE and PKE). Kendall's formula was used to find hamstring muscle-range. ASLR and AKE results were compared for means and correlation was assessed. PSLR and PKE results were compared for means and correlation was assessed.

**Result:** The average hamstring-range is about 79.34% (ASLR), 83.67% (PSLR), 77.92% (AKE), and 81.43% (PKE) of total joint range of hamstrings. There is significant difference between ASLR and AKE values and between PSLR and PKE values.

**Conclusion:** Total hamstring excursion in all methods confirms Kendall's statement. However difference between SLR and knee extension tests suggest that SLR values of hamstrings length and knee extension values of hamstrings length cannot be used interchangeably. Other mechanical factors may play role for the difference between these values.

**Implications:** Sequence of Hip flexion and Knee extension for hamstring length assessment has a significant effect on results and it should be considered by therapist before clinical decision making.

**Keywords:** Hamstrings length; ASLR; PSLR; Active knee extension test; Passive knee extension test; Muscle length

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## CORRESPONDING AUTHOR

\*<sup>1</sup>Dinesh Sorani

Senior Lecturer,  
Government Physiotherapy College,  
Jamnagar, Gujarat, India

<sup>2</sup>Tutor cum Physiotherapist,  
Government Physiotherapy College,  
Jamnagar, Gujarat, India.

## INTRODUCTION

The length of hamstring muscle is considered to play an important role in both the effectiveness and the efficiency of basic movements, such as walking and running [1,2]. Clinical observations have suggested that short hamstrings are associated with various problems, including specific disorders of the lumbar spine [3-9], general dysfunction syndromes of the low back [10,11,12], contractures resulting from deficits of the central nervous system [13-16], and sports-related injuries [17]. Due to these reasons, the assessment of length of hamstrings to find their tightness has an important role in physical assessment of normal people as well as patients.

Various clinical methods for assessment of hamstring tightness have been described [18, 19, 20, 21] and compared [21]. Kendall [22] described the method to measure the hamstring muscle length and correlate it to total joint range. However as per different sources described above common tests used to measure hamstring length are active or passive straight leg raising (SLR) and Active or Passive Knee extension test (KE) with hip into 90 degree flexion position. Both method lengthen the hamstrings, however sequence of joint movement is different. As Kendall has not specified joint sequence, rather has given formula for total sum of joint angle, the selection of joint remains unclear and it can be assumed that both methods give similar results. However, although studies have measured muscle length as separate muscle tests [18-20] only one study has compared these methods [21]. A muscle lengthening maneuver involves lengthening of muscles across all joints crossed by that muscle. For hamstrings this would mean that maximum possible hip flexion and knee extension is the required combination. A straight leg raising maneuver first lengthens hamstrings at knee joint followed by lengthening of muscles at knee joint. The knee extension test first lengthens hamstrings at hip joint first up to 90 degree hip flexion followed by lengthening of muscles at knee joints. Kendall explains that muscle length can be measured in the form of muscle length. As per Kendall when the hamstrings are in their shortest range, the minimum range would be when the hip joints are into full extension and knee joints are in full flexion. From this maximum allowable excursion of hip flexion and knee extension (regardless of sequence of joint movement, hip flexion first or knee extension first as in knee extension test or SLR test respectively) can be measured and that sum of angles at hip flexion and knee extension can be representation of hamstrings length. According to Kendall the muscle length adopted as a standard is approximately 80% of the total range of joint motion of the two joints over which the muscles pass [22]. Current study has hypothesized that both SLR test and knee extension test (whether active or passive) give similar results and show no difference and joint sequence does not affect hamstring lengthening. So current study aimed to measure active and passive SLR and active and passive knee extension tests and use Kendall's formula to find out the similarities between these values.

## MATERIALS AND METHODS

Sample size: 100 (The demographic data of the participants is present in Table 1)

**Table 1:** Demographic data

	Mean	Std. Deviation
AGE	20.83	1.170
HEIGHT (CM)	161.20	7.246

Study Design: Observational Study

Inclusion Criteria: Healthy Individuals without any history of trauma/pathology affecting Hamstring length

Exclusion Criteria: Individuals with any positive history of trauma/pathology affecting hamstring length.

*Procedure: 360 degrees goniometer was used to measure the range across the joints. Standard goniometry methods were used to measure hip flexion, knee flexion and hip extension as described by Cynthia Norkin [23]. Immediately prior to testing, each subject performed five active toe touches to lessen the effects of muscle lengthening from repeated trials during data collection.*

### Active SLR method (H-ASLR)

For ASLR method the following ranges were measured. The sequence of joint measurement was random but included all of the following

- Maximum active hip flexion angle in supine lying while the knee was in full extension
- Maximum active knee flexion angle in prone lying
- Maximum active hip extension angle while knee in full extension in prone lying

ASLR hamstring range was calculated as sum of all the above three angles.

### Passive SLR method (H-PSLR)

For PSLR method the following ranges were measured. The sequence of joint measurement was random but included all of the following

- Maximum passive hip flexion angle in supine lying while the knee was in full extension
- Maximum passive knee flexion angle in prone lying
- Maximum passive hip extension angle while knee in full extension in prone lying

PSLR hamstring range was calculated as sum of all the above three angles.

### Active knee extension method (H-AKE)

For AKE method the following ranges were measured. The sequence of joint measurement was random but included all of the following

- Maximum active knee extension in supine lying while the hip was maintained in 90 degrees flexion
- Maximum active knee flexion angle in prone lying
- Maximum active hip extension angle while knee in full extension in prone lying

AKE hamstring range was calculated as sum of 90 degrees hip flexion, maximum active hip extension and the difference between maximum active knee flexion and extension angles in above two measurements.

### Passive knee extension method (H-PKE)

For PKE method the following ranges were measured. The sequence of joint measurement was random but included all of the following

- Maximum passive knee extension in supine lying while the hip was maintained in 90 degrees flexion
- Maximum passive knee flexion angle in prone lying
- Maximum passive hip extension angle while knee in full extension in prone lying

PKE hamstring range was calculated as sum of 90 degrees hip flexion, maximum passive hip extension and the difference between maximum passive knee flexion and extension angles in above two measurements.

Maximum Hamstring range was calculated as sum of maximum hip flexion angle with knee fully flexed, maximum knee flexion angle and maximum hip extension angle (both actively and passively).

Percentage of hamstring range was calculated as

$$\frac{\text{measured hamstring range} \times 100}{\text{maximum hamstring range}}$$

Data were collected from both right and left side of all the participants.

### Data analysis

IBM SPSS 20 Statistics was used for data analysis. Student's t test was used for comparison. Level of significance was kept at 0.05%.

### RESULTS

Mean values of H-ASLR, H-PSLR, H-AKE and H-PKE are given in Table.

**Table 2:** Percentage hamstring length out of maximum range in percentage of total joint excursion.

	H-ASLR	H-PSLR	H-AKE	H-PKE
Mean (SD)	79.34 (5.43)	83.67 (4.79)	77.92 (4.51)	81.43 (4.21)

Table 3 shows t test results comparing the H-ASLR and H-PSLR values.

**Table 3:** Paired t test between hamstring range values between ASLR and AKE

	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
H-ASLR - H-AKE	4.050	11.855	.838	4.831	199	.000

The mean H-ASLR values were significantly higher than mean AKE values.

Table 4 shows t test results comparing the H-AKE and H-PKE values.

**Table 4:** Paired t test between hamstring range values between PSLR and PKE

	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
H-PSLR - H-PKE	6.225	9.829	.695	8.957	199	.000

The mean H-ASLR values were significantly higher than mean AKE values.

Table 5 shows correlation between H-ASLR, H-PSLR, H-AKE and H-PKE.

**Table 5:** Correlation between H-ASLR, H-PSLR, H-AKE, H-PKE

	H-ASLR	H-PSLR	H-AKE	H-PKE
H-ASLR	1	.941**	.814**	.815**
H-PSLR	.941**	1	.824**	.843**
H-AKE	.814**	.824**	1	.954**
H-PKE	.815**	.843**	.954**	1

\*\* Correlation is significant at the 0.01 level (2-tailed).

It can be seen from Table 5 that the values of different methods show positive correlation.

### DISCUSSION

Total 100 subjects participated in subjects and considering the either side data as individual data, total 200 data were collected. The mean age of the subjects was 20.83 years and mean height was 161.20 cm. Using Kendall's formula mean percentage of hamstring length out of maximum range in percentage of total joint excursion was found to be 79.34, 83.67, 77.92, 81.43 for H-ASLR, H-PSLR, H-AKE, H-PKE respectively (Table 2). These values are around 80 % as suggested by Kendall[22]. So the data from current study supports Kendall's statement.

When these tests were correlated, there was significant correlation between these techniques suggesting their reliability.

The Current study has hypothesized that both SLR test and knee extension test (whether active or passive) give similar results and show no difference and joint sequence does not affect hamstring lengthening. So H-ASLR and H-AKE were compared (Table 3) and H-PSLR and H-PKE were compared (Table 4). There is significant difference between H-ASLR and H-AKE values, which confirm that the sequence of joint recruitment during hamstring muscle length test affects their lengthening process. When H-ASLR is used, the muscles are already lengthened at knee joint and with hip flexion movement they are later lengthened at hip joint actively. Same applies for H-PSLR where the lengthening process is passive. When H-AKE or H-PKE is used, the muscles are lengthened at hip joint first, followed by knee extension when they are lengthened at knee joint actively or passively for respective methods. Current data suggests that hamstring excursion is about average of 4 degrees less with knee extension method. This suggest that other mechanical factors may be affecting measurement procedure and should be considered during assessment. According to Cynthia (2010) [24], pain perception during hamstring lengthening process may also affect their length along with their extensibility. Cynthia also suggested that torque required to produce end range hamstring length should also be measured during hamstring lengthening process. In our study torque was not assessed during both SLR and KE tests and it was participants' subjective feeling which limited ASLR and AKE tests and evaluators' subjective end feel perception which limited PSLR and PKE tests. Although torque was not assessed, authors of the present study propose that difference in pain perception in both methods can result in observed difference of these tests. Assuming that during SLR technique the hamstrings are

primary lengthened from their superior portion, whereas during KE technique, the hamstrings are primarily lengthened from their middle and lower portion, a difference in pain receptor concentration or their threshold can contribute to the result of these tests. Additionally if superior portion of hamstrings and inferior portion of hamstrings have different level of extensibility, it may also be reflected by these tests. As these factors were not analyzed by current study, further research is suggested.

## CONCLUSION

Total hamstring excursion in all methods confirm Kendall's statement. However difference between SLR and knee extension tests suggest that SLR values of hamstrings length and knee extension values of hamstrings length cannot be used interchangeably. Other mechanical factors may play a role for the present difference between these two values.

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