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Correlation Between Hamstring Flexibility and Eyes Open Stork Balance Test in Dominant Leg Among Middle Aged Adults - A Pilot Study

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ABSTRACT

BACKGROUND: Balance is the ability to maintain the body's position over its support area and is crucial for performance. It involves managing the alignment of the body against gravity and other forces. Musculoskeletal system with posture, the configuration of body joints, is essential for maintaining balance and body orientation in standing positions, which is vital for daily activities and sports. Hamstrings are particularly important in maintaining the alignment of the pelvis and lower limbs. Tightness in these muscles can reduce flexibility which affect the range of motion and alter lower body biomechanics. It is found that the prevalence of hamstring tightness is high and hamstring tightness increases from childhood to 40-49 years. This may lead to balance issue due to fatigue of intrinsic foot muscles.
OBJECTIVE: To find the relationship of Hamstring flexibility with Eyes Open Stork Balance Test among middle aged adults.
MATERIALS AND METHODS: A cross-sectional study was conducted among 15 older adults from tertiary hospital in Karnataka. Hamstring flexibility was assessed Active Knee Extension (AKE) test and balance was assessed by using Eyes Open Stork Balance Test (EOSBT).
RESULT: A strong positive correlation between hamstring flexibility and eyes open stork balance test ($r=0.987$; $p<0.001$) was observed and was statistically significant.
CONCLUSION: This study concluded that there is a positive correlation between Hamstring flexibility and eyes open stork balance test in dominant leg in middle aged adults.

Keywords: Hamstring Flexibility, Eyes Open Stork Balance Test, Balance, Hamstring tightness, Intrinsic foot muscle

INTRODUCTION

Balance is defined as the ability of maintaining the position of the body on the support area and it forms a basis for a better performance. The ability of human beings in redressing balance is a determinant for developing other motor system. In upright position, the individuals maintain the balance control by performing minimal motions by means of different parts of their bodies. In order to maintain the balance, centre of mass of the body must pass through an appropriate area of the sole. Musculoskeletal system plays a sensorial role by means of proprioceptors provided therein, and a mechanic role as an operator of the motion in

maintaining the balance. It is asserted that the most important muscles in maintaining the balance are dorsal muscles, Quadriceps femoris, hamstring muscles and soleus muscle. [1]

As hamstring muscles are known to be one of the most important muscles in the body due to their crossing two joints and connectivity to the pelvic bone.[2] It is the group of three muscles which are responsible for the different activities which range from standing to high energy sprinting and jumping.[3] So depletion in muscular flexibility not only decreases functional level but also causes damage to the musculoskeletal system due to overutilization. Such damage mainly occurs in multi-joint muscles which have large functional excursion and a high percentage of fast twitch muscle fibres, and the hamstring muscle has been reported to be the multi-joint muscle which is most frequently damaged in the human body.[4]

Zachezeweski has defined muscle flexibility "it is the capacity of a muscle to lengthen and allowing one joint to move through particular range of motion".[5] Which turnout to be the important factor for health-related physical fitness. In terms of physical length or flexibility of a muscle, muscle "tightness" is the inability to elongate and mild to moderate reduction in length. Hamstring tightness is described as reduced range of motion (ROM) around a knee and/or hip joint. Also, the individuals may feel tightness in the dorsal aspect of their thigh. It is stated to be a major cause for faulty and reduced movement of the hip and the knee among all age groups. There are various adverse effects of hamstring tightness in hamstrings. A few of them are reduced range of motion of lower limbs causing alteration in normal gait and in foot musculature, it is also linked to postural disturbances. Also, a few pathological conditions associated with hamstring.4 Incidence of hamstring tightness is higher in males than females. Hamstring tightness increases from childhood to 40-49 years. The maintenance of balance and body orientation in the standing position is essential for the performance of the activities of daily life and the practice of physical and sport activities. [6]

Posture can be acknowledged as the arrangement of the body joints, where, the set of angles that express the relative disposition among the segments of a body. Even when standing still, the body sways. For each new posture adopted by human beings, there are necessary neuromuscular responses to maintain body balance. The maintenance of body balance is a responsibility of the postural control system, which is a concept used to refer to the functions of the motor, nervous, and sensory systems.[7]

The hamstrings can lead to a posterior pelvic tilt because these muscles attach to the lower pelvis and extend to the back of the knees. When they are tight, they pull the pelvis backward. This posterior tilt can alter the normal curvature of the spine and shift the (LoG) posteriorly. The LoG is an imaginary vertical line that passes through the center of mass of an object. In humans, it typically passes near the body's center in a well-aligned posture. However, when the pelvis tilts posteriorly, the LoG shifts backward, which can affect balance and stability. To maintain balance with a shifted LoG, individuals may unconsciously increase the use of the intrinsic muscles of the foot. These muscles are responsible for movements such as plantar flexion, where the foot points downwards. This action can help counterbalance the posterior shift of the LoG. The intrinsic muscles of the foot are not accustomed to being overused in this manner. Over time, the increased demand can lead to muscle fatigue. Fatigued muscles are less effective at maintaining postural control and stabilizing the foot during weight-bearing activities. As the intrinsic foot muscles become fatigued, their ability to provide stability is compromised. This can lead to balance issues, increasing the risk of falls and other injuries, particularly during activities that require quick changes in direction or support on one leg. [8,9]

It is found that the prevalence of hamstring tightness is high. It is a common aspect even

among young healthy individuals and recreational athletes. Hamstring tightness increases as age increases up to 49 years. Since limited studies are done in middle age group population where the prevalence of hamstring tightness is more according to literature, it's important to know how it effects the balance in such individuals. Very few to studies has been done in the age group of 30-50 and in our clinical practice, we usually deal with a lot of hamstring tightness and balance issue cases. The purpose of this study was to determine the relationship between Hamstring tightness and Balance in middle aged adults. Add appropriate original references to the sentences/paragraphs taken from other media/sources.

MATERIALS & METHODS

SAMPLE:

15 middle aged adults between 30 to 50 years were recruited in study by purposive sampling.

Individuals with normal BMI (18.5 – 24.9 kg/m2) having hamstring tightness were included in study. Individuals with history of surgeries in 6 months, subjects with recent fractures or surgical interventions, subjects with any lower limb acute pain, history of any acute orthopaedic pain., subjects with any neurological disorders, balance issues and ambidextrous subjects were excluded. Approval was obtained from Institution Ethics Committee and informed written consent was obtained from all the participants.

PROCEDURE

Middle age subjects were recruited using convenience sampling technique. A brief explanation about the procedure was given to the participants. All the subjects were asked to fill a Proforma that included demographic data and baseline data like age, height and weight to calculate BMI. BMI will be evaluated to check if the participants fall in the normal B.M.I. category (18.5-22.9 kg/^{2}). Subjects not fulfilling will BMI will be excluded. For screening of change in length of hamstring muscle will be checked using active knee extension test from that the subjects having hamstring tightness will be selected and, in those individuals, balance will be Assessed using eyes open stork balance test which is a reliable and valid tool.

OUTCOME MEASURES:

Active knee extension test: To assess change in length of hamstring muscle.

For the AKET, each subject was asked to remove his or her shoes and will be positioned in supine. Kamalakannan et al described that the Active knee extension measurements were defined as the degree of knee extension from the knee at 90 degrees in relation to the hip at 90º. Then non-test limb was kept extended and the Dominant leg being measured was maintained at 90°of knee and hip flexion. Tiago et al described the position of goniometer and procedure of reading angle by stating the result recorded corresponded to the amplitude, in degrees, of the knee-extension movement, starting from the initial test position (knee flexed at 90° which corresponded to the goniometric 0°). Then person was instructed to actively extend the knee as far as possible at end point by holding for 5 seconds. Then the goniometer was placed to measure the angle created at the knee in degrees. The axis of goniometer was placed over the lateral epicondyle of the femur whereas the stationary arm was placed parallel to the lateral midline of the femur and the moving arm was parallel to the lateral midline of the fibula.

Eyes open Stork Balance Test: To access the balance.

Test is performed with eyes open without shoes for dominant leg. The subject was made to stand comfortably on both feet with hands on the hip and instructed to lift one leg and place the toes of that foot against the knee of the other leg. The subject was then asked to raise the heel and stand on their toes on command. The stopwatch will be started as soon as the heel will be raised from the floor. The stopwatch will be stopped if the hand(s) came off the hips or the supporting

foot swivelled or moved in any direction, or the non-supporting foot lost contact with the knee, or the heel of the supporting foot touched the floor. movement of the supporting foot in any direction, loss of contact between the free foot and the knee, and positioning the heel of the involved foot on the floor.

STATISTICAL ANALYSIS

Statistical analysis of the data was performed using SPSS 23.0. The categorical variables were presented as frequency and percentage. Continuous variables presented as mean and standard deviation. Correlation was performed using Karl-Pearson's coefficient. A p value <0.05 was considered statistically significant.

RESULT

Correlation between hamstring strength and balance

	Balance (in seconds)	
	r value	**p value**
Hamstring Flexibility (in degrees)	0.987	P<0.001

The correlation analysis between Hamstring Flexibility and Balance revealed an r-value of 0.987 with a corresponding p-value of 0.000. This indicates a strong significant positive correlation between hamstring flexibility and balance among the participants.

DISCUSSION

Balance is defined as the ability of maintaining the position of the body on the support area and it forms a basis for a better performance. Musculoskeletal system plays a sensorial role by means of proprioceptors provided therein, and a mechanic role as an operator of the motion in maintaining the balance. It is asserted that the most important muscles in maintaining the balance are dorsal muscles, Quadriceps femoris, Hamstring muscles and soleus muscle. Since Hamstring is two joint muscle it often leads to tightness.[1]

As Hamstrings play a crucial role in maintaining the alignment of the pelvis and the lower limbs. Tightness in these muscles can lead to a decrease in flexibility, which affects the range of motion (ROM) and can alter the normal biomechanics of the lower body. When the hamstrings are tight, they can pull the pelvis into a posterior tilt. This change in pelvic orientation can decrease the lumbar lordosis (the natural curve of the lower back) and shift the body's center of mass, which directly impacts static balance. The LoG is an imaginary line that ideally should pass through certain anatomical landmarks when the body is in a neutral position. Hamstring tightness can cause a posterior shift of the LoG, which forces the body to adapt its posture to maintain an upright position. To compensate for the altered LoG, the body may engage other muscles, such as those in the feet, to maintain balance. This can lead to increased plantar flexion, where the foot points downwards, to stabilize the body. Over-reliance on compensatory muscles, like the intrinsic muscles of the foot, can lead to fatigue. These muscles are not designed for prolonged or excessive use in maintaining static balance, which can diminish their ability to stabilize the body. As the intrinsic foot muscles become fatigued, their capacity to provide support and stability is reduced. This can lead to impaired static balance, increasing the risk of falls and affecting the ability to perform daily activities safely. [8,9]

Tight hamstrings can cause a posterior pelvic tilt, pulling the pelvis backward. This can change the spine's normal curvature and shift the Line of Gravity (LoG) posteriorly. Shamshi et al have shown in study how shortened hamstring muscles can negatively impact the function and biomechanics of the knee and hip joints, as well as lumbo-pelvic rhythm, leading to low back pain and Tightened hamstrings increase posterior pelvic tilt and reduce lumbar lordosis.[10] The LoG, an imaginary line through the center of mass, typically aligns with the body's center. A posterior pelvic tilt shifts the LoG backward, impacting balance and stability.

To counterbalance a shifted LoG, there may be an unconscious increase in plantar flexion, where the foot points downwards, utilizing the intrinsic foot muscles. Ghorbani et al in 2023 have shown in study foot posture affects static balance and proprioception in the ankle and knee joints, highlighting the importance of proprioceptive input from the lower limbs in maintaining upright stance.[11] Mc keon et al did a study where he discussed how the foot's complex structure and its arch play a crucial role in both static posture and dynamic activities and concluded that the stability of the arch, controlled by intrinsic and extrinsic muscles, is essential to normal foot function, and the intrinsic muscles act as local stabilizers and sensors of foot deformation.[12]

These intrinsic muscles are not used to such demands and can become fatigued over time, reducing their effectiveness in postural control and stabilization during weight-bearing activities. Fatigue in the intrinsic foot muscles can compromise stability, leading to balance problems and a higher risk of falls and injuries, especially during daily activities. Ridge et al described as loading and postural demand increased the intrinsic foot muscle activity where fatigue of these muscles can lead to balance issues increased and concluded that intrinsic foot muscles play an important role in maintaining static balance.[13] Jaffari et al in study conducted tells that on how strength training of the intrinsic foot muscles and resulting improvements in foot function and balance there by discussing intrinsic foot muscles play a major role in maintaining balance.[14] Wei Z et al discussed intrinsic foot muscle plays major role in maintaining balance analysed the effects of intrinsic foot muscle training on foot function and postural.[15]

In the present study found good positive correlation was observed between Hamstring Flexibility and Eyes Open Stork Balance Test and the relationship was found to be statistically significant ($r=0.987$; $p<0.001$) which shows reduced in Hamstring Flexibility leads to Balance Issues.

A limitation of this study is the relatively small sample size. Lack of control group and convenience sampling technique used in the present study also limits generalization of the findings. Further studies with larger sample may be planned in order to address some limitation of the present study.

CONCLUSION

The study concluded that there is a positive correlation between hamstring flexibility and Eyes Open Stork Balance Test in middle aged adults. As the hamstring flexibility plays an essential role in maintaining balance where balance was assessed by using eyes open stork balance test. This makes an important diagnostic tool during balance assessment of an individual with hamstring tightness.

Declaration by Authors

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