Journal of Clinical and Biomedical Sciences

Review Article

Hamstring Flexibility in Adolescent with or Without Plantar Flexion- A Narrative Review.

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Abstract

Background: Flexibility is a property of the muscle to be lengthened to achieve required range of motion. Hamstring muscle constitutes posterior compartment of thigh, which consists of semimembranosus and semitendinosus, biceps femoris, and primarily response for knee flexion. As the age progress, there is physiological shortening of hamstring muscle due to various reasons.
Objectives: Is to review the literature for hamstring flexibility measurement in relation to plantar flexors in adolescent between 12 to 19 years.
Methods: The analysis of literature was done through Google Scholar, PUBMED, and EMBASE MEDLINE. The review period is from 2016 to 2021 which includes articles of full text English originated.
Results and conclusion: In search of article we found 50 articles out of it there were 14 articles which describe about the assessment of hamstring flexibility. There are different assessment tool were used to find the hamstring flexibility. However, there is limited literature associated to hamstring flexibility with or without plantar flexion. There is dearth of literature review on the adolescent for hamstring flexibility, positive review of comparison of study between plantar flexion and neutral position, back saver sit and reach test is more comfortable test than other test. In addition to it adapted sit & reach box has absolute validity & reliability and there is negative correlation between thoracic spine and hip component for the same.
Keywords: Hamstring Flexibility, Sit and Reach box (SRT), Back Saver sit and Reach box test (BSRT) and Chair Sit and Reach Test (CSRT).

Introduction

Flexibility is defined as an ability of muscle to lengthen the end range of motion; it is influenced by muscle, tendons, ligament and bones.[1] Hamstring muscles are primary muscles responsible for flexion of knee they are located posterior compartment of thigh.[2] It consists of semitendinosus, semimembranosus and biceps femoris[2], Secondary action of the muscles is hip extension and abduction.[3] There is continuity of myofascial band joining the biceps femoris tendon and ligaments attached to sacro-tuberocity. An adjuvant fascia connects the semitendinosus and gastrocnemius muscle, which has multiple fascia insertions with the neighbouring structure such as hamstring and soleus. A deep fascia extends between the popliteal fossa, superior hamstring muscle and inferior gastrocnemius which creating link between the muscle.[4] During the adolescent growth period, there is a rapid shortening of length tension of hamstring muscles which is also called as physiologic shortening of hamstring that connected with the natural developmental of lumbar curvature and tilt of pelvic in this period.[5] In healthy children hamstring muscle shortening during growth spurt is one of the physiological properties which shape the curvature of spine from child to adult posture.[6]

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Conflict of Interest: None
Financial Aid: Nil
Submitted: 15-02-2022
Accepted: 13-07-2022
Published: 10-10-2022.

Hamstring Flexibility Measurement

A Sit and Reach box (SRT) is a T shaped box with foot support and scale measurement on the top of the T as shown in the (Figure:1,2&3). The subject places his/her foot inside the box with knees extended, both the hand is overlapped and asked to bend forward to reach the maximum readings measured in the scale which is marked on the top of the box. The participant with full extended legs and foot in neutral has to do three attempts for getting the maximal flexibility assessment. The SRT will assess the flexibility of lumbar spine, thoracic spine and also the hamstring length tension.[7]

On the other, back saver sit and reach box test (BSRT), the individual is asked to extended one leg and forward trunk flexion is done to check the flexibility of unilateral hamstring muscles. The legs are placed 7 to 10 cm side to prevent the thoracic and lumbar spine flexion. This test will provide unilateral hamstring flexibility assessment only where the plantar flexion component is not taken into consideration.[7] The modified chair SRT, ask the participants to straight the one leg in front of their hip with the heel on the floor and ankle is placed in dorsiflexed and bend the other one so that the foot is placing on the floor about 15-30cms to the side of the midline of body with the extended leg as possible and hand is moved on the box, subject was instructed to reach down the stretched leg in an attempt to touch the toes in straight spine.[7] A touch short of the toes was recorded as minus score and beyond the toes was recorded as plus score.[7]

All the sit & reach box measures the hamstring flexibility with neutral foot which raises a query tight soleus muscles, this short fascia link of soleus and hamstring results in literature review of hamstring flexibility measurement with or without plantar flexor.

Figure 1: Anterior view of SRB

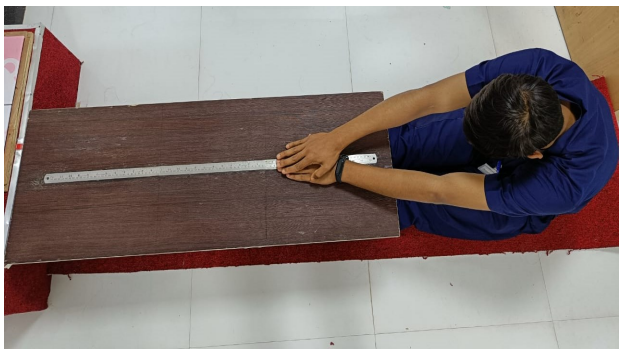

Figure 2: SRT with neutral position of ankle

Figure 3: Ankle in plantar flexion of SRT

Method and Methodology

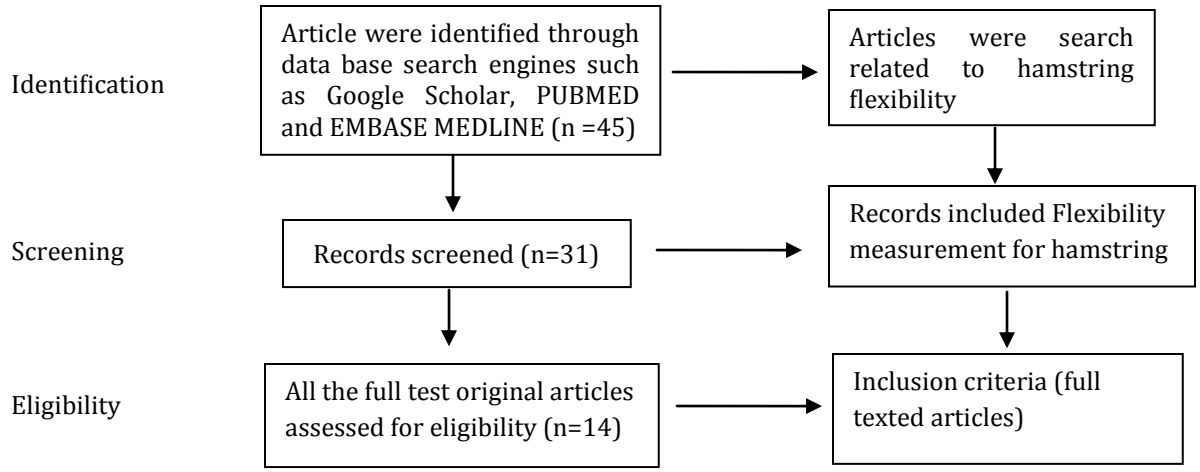

Table 1: Summarized findings and interpretation of studies.

Author	Title	Equipment	Age Group/ Population	Sample Size	Findings
Morphology of Hamstring Muscle					
Brain J Krabak MD, Edward R Laskowski MD, / 2001	Neuro physiologic influences on hamstring flexibility: A pilot study	Goniometer , hand dynamometer	Patient whose lower limb underwent surgery for unilateral limb without previous injury in contra lateral limb(13-65 years)	15 members	The neural system have role in regulating intrinsic viscoelastic property of muscle. Muscle fiber system can be altered with motor neuron activation which leads stretch. Finally they say combination of both mechanical and neuron will contribute for hamstring flexibility.
T Kumazaki, Y. Ehara, T. Sakai / 2012	Anatomy and physiology of hamstring injury	Electromyography	Cadaver	13	The recognition of anatomical and physiological basis hamstring muscle injuries is helpful to reduce the incident of muscle strain by instructing sports athletes to avoid risk postures and movements in sports.
Carlos Cruz Montecinos, Alberto Gonzalez Blanche , David Lopez Sanchez/2015	Relationship between pelvis motion and deep fascia displacement of the medial gastrocnemius anatomical and functional implication	5-10MHz linear transducer , GoPro Hero 3 camera	Sedentary young male	17 members	There is deep fascia connective from pelvic to leg .this reinforces the function forces which transmission through synergistic muscle group and function of the fascia in restricting movements.
Xianglin Wan, Feng Qu, William E Garrett, Hui Liu, Bing Yu / 2016	Relationship among hamstring muscle optimal length and hamstring flexibility and strength		College students (24-28 years) recreational athletes	21 members	Hamstring flexibility may affect hamstring muscle strain , hamstring muscle optimal length were significantly correlated to hamstring flexibility and hamstring muscle optimal length is not significantly correlated to corresponding length hamstring muscle in standing.
Yasser Ramzy Lasheen, Neveen Abdel Latif Abdel Raoof, Ramy Edward Assad/2017	Influence of bilateral hamstring muscle shortening on some radiological parameters of lumbosacral spine	Radiological parameters	26-31 years	30 members	The lower spine and its angle (lumbar lordosis angles, lumbosacral angles and sacral inclination angle) were affected by bilateral hamstring muscle shortening.

Karolina Stepien, Robert Smigielski, Caroline mouton/2018	Anatomy of proximal attachment, course and innervations of hamstring muscle, a pictorial essay		cadaver		The high prevalence injuries muscles are long head biceps femoris and semitendinosus. Know about the structural changes which helps us to understand underlying pathological conditions helpful in treatment.
C Azzopardi, G Almeer, J, Kho, D. Beale, S. L. James, R. Botchu / 2020	Hamstring origin – anatomy, angle of origin and its clinical implication	MRI	Under age 40 years	100	The angle of origin of conjoint tendon and hamstring muscles. This helps us to discover the tendon work during the muscle action the resulting force applied to the individual components of the hamstring compartment.
Hamstring Flexibility Assessment					
Stanley Sai – Chuen Hui and Pak Y Yuen/1999	Validity of modified back saver sit and reach test :	Classical sit and reach box, modified classical sit and reach box and meter rule	17 -41 years	158 participant (96 female and 62 male)	The MBSRT is comparative better than the other protocols.
Baltaci U, Tunay A Besler S Gerceker 2003	Comparison of three different hamstring flexibility in female students.	Sit and reach box , folding chair & goniometer	20 -24 years	102 females	The BSRT is more precise and accurate measures of hamstring flexibility, it is safe & comfortable.
Pedro A Lopez Minarro , Pilar Sainz de Baranda Andujar , Pedro L Rodriguez Garcia/2009	A comparison of the SRT and the BSRT and reach test in university students	Sit and reach box & inclinometer	23 to 28 years	143 participant (67 women and 76 men)	Significant differences were only observed in the thoracic angle between SRT, back saver sit and reach test where as traditional method shows slightly higher correlation value than BSRT and other reach test.
Palma chillon, Jose Castropinero, Jonatan R Ruiz Et.al/2010	Hip flexibility in main determinant of BSRT and reach test in adolescent	Standardized sit and reach box	14 to 17 years	138 adolescents (81 males & 57 females)	Hip flexibility is main determinant of the back saver sit and reach test in adolescents and scores derived from BSRT and reach test and SRT are comparable.
F. Ayala, P. Sainz de Branda, M .Deste Croix, F Santonja/2011	Criterion Related validity of four clinical tests used to measure hamstring flexibility in professional futsal players.	Sit and reach box	17 to 30 years	103 athletes (55 males and 48 females)	The sit and reach test , toe touch test, BSRT ,MBSRT , SRT have moderate criterion validity for estimating hamstring flexibility in female player but not for male players.
Mayorga – vega D, Merino Marban R and Garcia Romera JC/2013	Validity of SRT with plantar flexion test in children aged 10-12 years	Classical sit and reach box (wooden box)	10-12 years	72 students (40 boys and 32 girls)	The uncovering of this study suggests that the hamstring extensibility should be assessed with plantar flexion.

Partricia Patterson, Denise L Wiksten, Lori ray, and Dwan Sanphy/ 2013	The Validity and reliability of the back saver sit and reach test in middle school girls and boys	SRT box and goniometer	11-15 years	88 middle school students (46 girls and 42 boys)	Back saver sit &reach test is similar to SRT and modified SRT of hamstring flexibility and further work should be directed towards validity
Daniel Mayorga Vega, Rafael Merino – Marban and Jesus Viciana/2013	Criterions Related validity of sit and reach for estimating hamstring and lumbar extensibility – A Meta-Analysis.	SRT	Any age	34 studies	SRT have average mean correlation co efficient of criterion validity for approximate hamstring extensibility but have low validity for lumbar extensibility and further research should be done.
Andrea Perin ,Leandra Ulbricht, Eduardo Borba Neves/2015	Contribution of body segments in Sit and Reach Test	SRT Box	18 to 19 years	195 young males	There is a inverse correlation between the upper back spine and hip is indicated and to identify the compensatory mechanisms.
Mona Frey, Alison Poynter, Keisha Younge, Diana De Carvalho/ 2018	The relationship between lumbopelvic flexibility and sitting posture in adults women	Accelerometers and SRT box	18 -69 years	41 females adults	Hamstring flexibility does not influence sitting posture but pelvic flexibility does and for different movement strategies contribute to SRT which should be researched further.
Carlos Ayan Perez**,** Sofia Alvarez Perez Sara /2018	Influence of the box dimension on the reliability and validity of the SRT in preschoolers	Standard Sit and reach box and adapted sit and reach box	4 to 6 years	148 children	It is advisable to use ASRB (with reduced dimension).
Diulian Muniz Medeiros, Leticialleal prates Miranda, Vanessa Bernardes Marques, Joao Breno de Araujo Riberio Alvares and Bruno Manfredini Baroni/ 2019	Accuracy of the functional movement screen active straight leg raise test to evaluate hamstring flexibility in soccer players.	Gravitational inclinometer	18 – 24 years	103 male soccer	The FMS & ASLR test does not satisfactory stratify the hamstring flexibility in soccer players compared to PSLR (passive straight leg raise).

Discussion

Morphology of Hamstring

Hamstring muscle complex has major significance in human kinematic chain, which is directly influencing the function of lower limb and maintaining the posture upright. Biceps femoris helps to rotate tibia and fibula laterally and prevents medial rotation of tibia, semimembranosus and semi tendinosus muscle helps tibia to rotate medially and prevents lateral rotation of tibia.[3] The angle of origin of conjoint tendon and hamstring muscles helps to learn out the tendon during the muscle work of resulting force applied to the individual components of the hamstring compartment.[9] Biceps femoris long head and semimembranosus has morphological features of hemi pennate, and semitendinosus muscle with fusiform architecture and biceps femoris of short head with slanted trapezoid architecture.[8] There is a high prevalence of getting injuries over the long head of biceps femoris and semitendinosus. So by knowing the anatomical, morphological structure that helps to understand the underlying pathological conditions

which helps in treatment protocol.[3] The neural system have role in regulating intrinsic viscoelastic property of a muscle. The Muscle fiber system can be altered with motor neuron activation which leads to the stretch, combination of both biomechanics and neuron system will contribute for hamstring flexibility.[10]

Hamstring and gastrocnemius muscle have three links found between them and the fascia of posterior leg muscles. The fascia starts from sacrotuberous ligament and connects the myofascial complex of hamstrings, along with it a deep fascia connects the gastrocnemius and popliteal region which gets inserted in the posterior part of tibial upper plateau.[4] In addition a deep fascia which originates from pelvis passes deeply to the posterior compartment of leg which reinforces the functional concept of forces transmission through synergistic muscle group and role of the fascia in restricting in the movements of knee joint.[4] Hamstring flexibility affects the hamstring muscle strain and hamstring muscle optimal length, which can significantly correlate with the hamstring flexibility, In which the hamstring flexibility is negatively correlated to hamstring strength and hamstring muscle optimal length.[11] The lumbosacral spine angle, lumbar lordosis angle, lumbosacral angle and sacral inclination angle were affected by bilateral hamstring muscle shortening.[12]

Hamstring Flexibility Assessment

It is been assessed by various methods, the common method used were sit and reach test (SRT) , Back Saver Reach Test (BSRT), Chair Sit and Reach test and Passive Straight Leg raise. The main determinant of the BSRT- hip flexibility in adolescents and scores derived from BSRT and SRT are comparable.[13] The SRT, toe touch test, modified SRT and BSRT have moderate criterion related to the estimation for estimating hamstring flexibility in female futsal player, but not for male players and there is a high reliability of SRT, toe touch test, BSRT than passive straight leg raise and modified sit and reach test.[14] So, the study suggest that the hamstring extensibility should be assessed with plantar flexion.[15]

The modified BSRT is comparatively preferable test than the other protocols.[16] The BSRT is accurate and firm measures of hamstring flexibility and safe & comfortable compare to others.[7] Whereas a suggestive difference is only observed in the thoracic angle between SRT and BSRT and traditional SRT shows slightly higher correlation value than BSRT.[17] The SLR does not satisfy or stratify the hamstring flexibility in soccer players compared to passive straight leg raise.[18] The SRT show modest correlation which is a co-efficient of criterion associated with the estimating hamstring extensibility. However there is a low validity for lumbar range of motion hence further study should be done to estimate the association of the same.[20] There is a negative correlation between the hip and upper back spine which indicates there is compensatory mechanisms.[21]

Hamstring flexibility does not influence sitting posture but pelvic flexibility does and different movement strategies contribute to SRT which should be researched further.[22] It is advisable to use adapted SRT box (with reduced dimension) because it provides absolute reliability and criterion related validity.[23] Though various protocols were adopted to evaluate the hamstring muscle length tension, all the test are limited to neutral ankle joint, only one study aimed to study the relationship of hamstring flexibility and plantar flexors.

Limitation

This review aimed to study the various methods of hamstring flexibility assessment and also its relationship with plantar flexors only, whereas the literature compress of last few years' data (2011-2021) and quality/level of evidence is not addressed in this review.

Conclusion

The back saver sit and reach test (BSRT) an accurate and comfortable method to assess the hamstring flexibility. The chair sit and reach test is adaptable to old aged population only which shows higher reliability. All the sit & reach test protocol shows negative correlation with hip and thoracic range of motion. There is dearth of literature to associate hamstring length tension and plantar flexors.

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