ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2019; 5(4): 274-278
www.allresearchjournal.com
Received: 07-02-2019
Accepted: 09-03-2019

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A comparative study on immediate effects of traction straight leg and bent leg raise on hamstring muscle flexibility in normal individuals

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Abstract
Background: Muscular flexibility is an important aspect of normal human function. Limited flexibility has been shown to predispose a person to several musculoskeletal overuse injuries and significantly affect a person's level of function. The objective of our study was to find out the effect of mulligan Traction Straight Leg Raise (TSLR) on hamstring flexibility, to find out the effect of Mulligan bent Leg Raise (BLR) on hamstring flexibility & Comparison of Mulligan TSLR & Mulligan BLR on hamstring flexibility in normal individuals.
Method: For the present study, a total of 124 physiotherapy students were screened; of which 50 adults with hamstring muscle tightness were recruited and randomly divided into two groups: Group A- given Mulligan Traction Straight Leg Raise and Group B- given Mulligan Bent Leg Raise. Hamstring flexibility was measured before and after the application of each stretching technique with the use of sit and reach test.
Results: Paired t test showed significant improvement in hamstring muscle flexibility on pre-post values for Group A-Traction Straight Leg Raise (12.597 ± 2.842, 17.80 ± 3.060) at $p<0.0001$. Also, Wilcoxon Signed Rank Test showed significant improvement in hamstring muscle flexibility on pre-post values for Group B-Bent Leg Raise (12.152 ± 3.024, 15.423 ± 2.80) at $p<0.0001$. However, Traction Straight Leg Raise (5.203±1.518) was more significant than Bent Leg Raise (3.271±1.341) at $p<0.0001$ on the Mann Whitney Test.
Conclusion: Thus both Mulligan's Traction Straight Leg Raise and Bent leg Raise are effective in improving the hamstring muscle flexibility in normal individuals, but Mulligan's traction straight leg raise technique was more effective in improving hamstring flexibility.

Keywords: Traction Straight Leg Raise, Bent Leg Raise, Hamstring muscle flexibility, Normal Individuals

Introduction
Flexibility is defined as the ability of a muscle to lengthen, allowing one joint or more to move through a range of motion (ROM), and is an essential component of normal biomechanical functioning [1, 2]. Muscle extensibility is an essential element of biomechanical function [3]. Limited muscle extensibility is a common problem that affects various patient populations as well as healthy able-bodied individuals [4, 5, 6]. The ability of an individual to move smoothly depends on his flexibility, an attribute that enhances both safety and optimal physical activities [7]. Flexibility is an important physiological component of physical fitness, and reduced flexibility can cause inefficiency in the workplace and is also a risk factor for low back pain [7]. The posterior femoral muscles, biceps femoris, semitendinosus, and semimembranosus, are colloquially termed the 'hamstrings. The flexibility of hamstring muscle is important for general and athletic population and of almost importance for health care professionals, to achieve this goal one needs to know the most effective and efficient technique to gain hamstring flexibility [8]. Lack of hamstring muscles extensibility conditions a decrease of pelvic mobility [9]. This invariably leads to biomechanical changes in the pressure distribution of the spine and consequent spinal disorders [10]. Therefore, poor hamstring extensibility has been associated with thoracic hyper kyphosis [11], spondylolysis [12], disc herniation [13] changes in lumbopelvic rhythm [14] and low back pain [15]. Hamstring tightness is also associated with low back and lower extremity musculoskeletal disorders leading to biomechanical changes of the pelvis and low back [16].

Stretching techniques are the treatments used to improve muscular extensibility to improve ROM, and can help prevent damage in daily life or sports, reduce muscle pain, and improve muscle capability. There are various treatment for the hamstring stretching like active release technique, passive stretching, static stretching [17], PNF Stretching Techniques [18, 19], eccentric stretching exercises [20] for improving hamstring flexibility. Brian Mulligan has developed a most ingenious compilation of manual techniques. Unlike the other mobilization procedures, Mulligan performed while patients were moving, either actively or passively, or while they were performing a resisted muscle contraction [21]. Indications for use of Mulligan's Traction Straight Leg Raise (TSLR) and Bent Leg Raise (BLR) techniques are limited range of motion of hip flexion together with low back pain with or without referred leg pain. The intention of this technique is to restore normal mobility. It stretches the lower extremity muscles in combination of hamstring, adductors and rotators. The Traction Straight Leg Raise and Bent Leg Raise techniques are painless interventions that are said to have immediate benefits [22]. Hence this study is designed to compare the effectiveness of two forms of manual therapy interventions such as Traction Straight Leg Raise and Bent Leg Raise techniques on hamstring muscle flexibility.

Procedure

The study was conducted in the duration of September 2018 till March 2019. Ethical approval was taken from the ethical committee. Total of 124 physiotherapy students were screened for hamstring muscle tightness. Hamstring muscle tightness was assessed using 90-90 hip and knee extension test. Subjects were in a supine position. Passive flexion of hip joint was done while the knee was fully extended to the end point where firm resistance was detected in the hamstring muscle group. Any person whose contra lateral hip goes into flexion will be included for the intervention. Total of 50 students were selected based upon the inclusion and exclusion criteria. Inclusion Criteria- 1.Physiotherapy students. 2. Age 18-25 years. 3. Hamstring muscle tightness - 90-90 hip knee extension test positive. Exclusion Criteria- 1.Any musculoskeletal pain or deformities of the lower extremity. 2. Any neurological symptoms affecting the lower limbs. 3. Subjects performing regular exercises or stretching. 4. Non willing population. Participants were informed about the aim, objective and method of the study. Samples were divided into 2 random groups via lottery system- Group A and Group B. Pre-interventional readings for hamstring flexibility was taken using the sit and reach test. Group A (n=25) was given Mulligan's Traction Straight Leg raise (TSLR) technique. Whereas, Group B (n=25) was given Mulligan's Bent Leg Raise (BLR) technique. Immediate post-interventional readings for hamstring flexibility was taken using the sit and reach test. The data was then analyzed and results were obtained. Outcome Measure was Sit-and-reach (SR) test in which a fingertips-to-tangent feet distance is measured are probably the most widely used lineal measures of flexibility.

Group A: Mulligan Traction Straight Leg Raise [24]

The subjects lay supine with their arms by their sides and a single pillow under the head. Sustained maximum traction force to the limb, applied in line with the long axis of the leg, with the knee extended. The limb was simultaneously moved passively through the range of SLR to the onset of discomfort and then immediately returned to the resting position. Three repetitions of Mulligan's Traction Straight Leg Raise were done with 7 seconds hold and 5 seconds relax time. The pain free Traction Straight Leg Raise was given for 3 repetitions.

Fig 1: Traction Straight Leg Raise Technique

Group B: Mulligan Bent Leg Raise [25]

Participant was in supine lying on a high couch with the investigator in walk stand position lateral to the leg, which was being stretched. Hip and Knee of the side to be stretched was bent at 90˚- 90 ˚. Participant's flexed knee was placed over the shoulder, the popliteal fossa of the knee resting on the shoulder. A distraction (longitudinal traction force along the long axis of femur) was applied at the lower end of femur and the participant was asked to push the shoulder with his or her leg followed by voluntary relaxation. The traction was maintained throughout the technique. At this point of relaxation, the bent knee was pushed up as far as possible in the direction of the shoulder on the same side in a pain free range. This stretch was sustained for 7 seconds and then 5 seconds of relaxation. If the pain or restriction eased, the hip was taken further in to flexion. It was ensured that there was no pain during the procedure; if it was painful the direction of the leg raise was altered medially or laterally. The process was repeated 3 times till the knee of the participant was beyond the shoulder of therapist. The contra lateral leg was kept relaxed and allowed to move as it goes.

Fig 2: Mulligan's Bent Leg Raise Technique

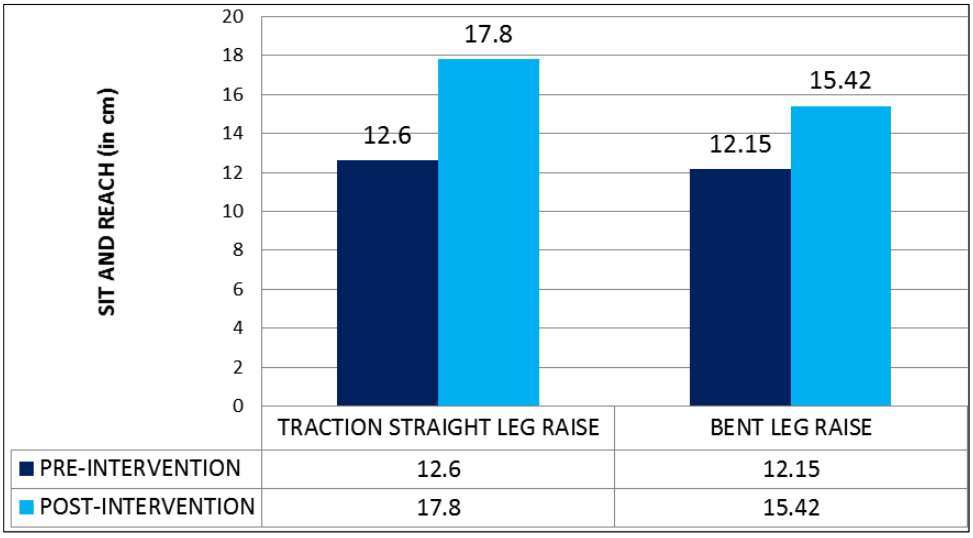
Data analysis and results

Statistical analyses were performed using the Graph Pad INSTAT software. Total sample of 50 was divided into two groups. Group A -Traction Straight Leg Raise (n=25) statistical analysis of normally distributed data was done using Paired t test. (Table 1) Group B given Bent Leg Raise (n=25) statistical analysis of uneven distribution of data was done using the Wilcoxon Signed Rank Test. (Table 1) The comparison between data of Group A and Group B was done using Mann- Whitney Test. (Table 2)

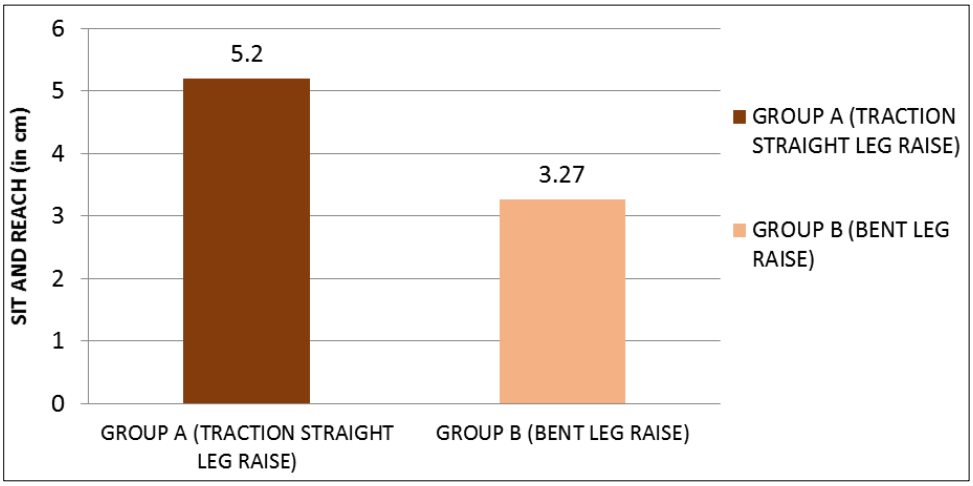
Table 1: Mean Values of Pre and Post Intervention of Group A (Traction Straight Leg Raise) and Group B (Bent Leg Raise)

	Group A: Traction Straight Leg Raise	Group B: Bent Leg Raise
Pre Intervention Mean	12.597 ± 2.842	12.152 ± 3.024
Post Intervention Mean	17.80 ± 3.060	15.423 ± 2.80
P Value	<0.0001 (extremely significant)	<0.0001 (extremely significant)

In the above table, it is seen that both traction straight leg raise and bent leg raise are statistically significant in improving the hamstring muscle flexibility.



Graph 1: Comparison between Pre and Post Intervention between Group A (Traction Straight Leg Raise) and Group B (Bent Leg Raise)



Graph 2: Comparison of Mean differences Between Pre- and Post- Intervention Values Of Group A(Mulligan's Traction Straight Leg Raise) and Group B (Mulligan's Bent Leg Raise)

Table 2: Mean values differences Between Pre- and Post- Intervention Values Of Group A (Mulligan's Traction Straight Leg Raise) and Group B (Mulligan's Bent Leg Raise)

Groups	Mean Difference	P Value
Group A- Traction Straight Leg Raise	5.203±1.518	<0.0001 (extremely significant)
Group B- Bent Leg Raise	3.271±1.341	

In the above table, it is seen that when both the Groups are compared for improvement in hamstring muscle flexibility, Group A- Traction straight leg raise is statistically more significant than Group B- bent leg raise.

Discussion

The purpose of present study was designed to compare the immediate effects of Mulligan's Traction Straight Leg Raise and Bent Leg Raise on hamstring flexibility in normal

individuals. When the hamstring flexibility values using the sit and reach test were compared in between the GROUP A – Traction Straight Leg Raise, it was found that there was significant statistical improvement ($p<0.0001$) in the hamstring flexibility in post-interventional values (17.80 ± 3.060) from pre-interventional values (12.597 ± 2.842).The increase in straight leg raise range in Traction Straight Leg Raise group may be due to the fact that during Traction Straight Leg Raise stretch, various receptors exert an inhibitory influence on lower limb alpha-motor neuron activity. Golgi tendon organs around the knee, hip and spine probably initiate various segmental reflex pathways during traction of the limb. Likewise, Golgi tendon organs are activated during large amplitude stretching movements such as SLR. This processing of information in the nervous system may inhibit the activity of the muscles being lengthened during SLR by dampening the afferent activity of type II muscle spindles or by decreasing motor neuron excitability via 1-b fibers. Hence, improvement in range of SLR may be directly related to inhibition of the hamstring muscles rather than changes due to stretch tolerance [26]. In straight leg raise static stretching with traction was given in which the muscle is slowly elongated to tolerance and the position held with the muscle in its greatest tolerated length [27]. Traction has shown to improve painfully restricted straight leg raise in previous studies [28]. Also a recent study, found that straight leg raise traction technique significantly improved the SLR angle with similar explanation for the cause of improvement of range [29]. A study done by Roopa Desai on "Carryover effect of Mulligan Traction straight leg raise in individuals with hamstring tightness" which concluded that a single intervention of Mulligan Traction straight leg raise technique was effective in improving Active knee extension angle and Sit and Reach extensibility and also that it has shown improvements in sustaining and maintaining the increased ROM and hamstring extensibility even after 24 hours in normal individuals also supports our findings for improvement of hamstring flexibility by Traction Straight Leg raise [30]. Also in the current study, when the hamstring flexibility values using the sit and reach test were compared in between the GROUP B – Bent Leg Raise, it was found that there was significant statistical improvement ($p<0.0001$) in the hamstring flexibility in post-interventional values (15.423 ± 2.80) from pre-interventional values (12.152 ± 3.024). "Brian Mulligan" has advocated the use of bent leg raise for stretching hamstring to improve flexibility by increasing the range of motion. This intervention consists of contract relax cycles applied to hamstrings that provide peripheral somatic input by the way of contracting muscles and the cutaneous contact of the therapist. Changes in alpha and gamma motor neuron activity (influencing the hamstring muscles) at a segmental level are likely following this technique that are similar to those effects observed following the implementation of proprioceptive neuromuscular facilitation (PNF) techniques and this may affect the subject's perception of their straight leg raise (SLR) limit. This strongly supports the evidence that, Mulligan's bent leg raise technique is a painless technique, when indicated and can be tried on any patient who has limited or painful SLR [27]. BLR produced a change of 3 to 4 centimeters difference in pre and posttest measures when observed within groups. Result of our study are supported by Oves Patni *et al*. which concluded that the BLR produced a change of 3.7 and 4 centimeters difference in pre and posttest measures when observed within groups [31]. One of the beneficial effect of the BLR technique might be a change in stretch tolerance of the hamstrings. This increase in hamstring muscle flexibility obtained by Bent Leg Raise also relates with the findings of Vijay and Ratnam who studied the immediate effect of active release technique vs. Mulligan Bent Leg Raise in subjects with hamstring tightness: a randomized clinical trial. Result of the study demonstrated that ART and Mulligan BLR increases immediate post intervention hamstring flexibility and range of motion. Both the groups showed improvement in popliteal angle and sit and reach flexibility measurements [32]. Study done to compare the effectiveness of Mulligan's straight leg raise traction and bent leg raise on hamstring flexibility suggested possible mechanism for pain relief can be due to static stretching that increases flexibility of muscles. In the current study, when the mean difference between pre-and post- interventional values of hamstring flexibility was compared between both the groups, it was found that Group A- Traction Straight Leg Raise (5.203±1.518) was statistically more significant in improving hamstring flexibility than Group B- Bent Leg Raise (3.271±1.341), with the p value<0.0001. This result can be supported by the study done by Pratishtha K. & Jagga V. in which the TSLR group the EMG activity decreased by 22.52%, thus suggesting improved muscle performance as decrease in muscle activity shows that muscle is able to do the same work with less recruitment of motor units thus rendering it more efficient, while in the BLR group the EMG activity increased by 14.64%.

Conclusion

The study concludes that both Mulligan's Traction Straight Leg Raise and Bent leg Raise have immediate effects in improving the hamstring muscle flexibility in normal individuals, but when both the techniques were compared, it was found that Mulligan's traction straight leg raise technique was more effective in improving hamstring flexibility.

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