ORIGINAL ARTICLE

Comparison between dynamic oscillatory stretch technique and static stretching in reduced hamstring flexibility in healthy population: A single blind randomized control trial

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Abstract

Objective: To compare the effects of dynamic oscillatory stretch and static stretching techniques in order to improve hamstring extensibility in healthy individuals with asymptomatic hamstring tightness.

Method: The single-blind randomised controlled trial was conducted from March to June 2018 at Sadiq Hospital, Sargodha Institute of Health Sciences, and District Headquarter Teaching Hospital,Sargodha, Pakistan, and comprised young healthy individuals with hamstring tightness who were randomly divided into groups 1 and 2, with the former getting exposure to oscillatory stretch technique and the latter to static stretching technique. Assessment of hamstring length was done using reliable clinical measurement test along with pain for stretch tolerance during passive straight leg raise using numeric pain rating scale. Measurements were taken at baseline, immediate (10min) and 1 hourpost-intervention. Data was analysed using SPSS 20.

Results: Of the 83 subjects, 42(%) were in group 1 with a mean age of 24.22±4.09 years, and 41(%) were in group 2 with a mean age of 25.85±6.09 years.Group1 showed significantly more improvement in all variables of hamstring flexibility and perceived pain at both post-intervention checkups compared to group 2 ($p<0.05$).

Conclusion: Dynamic oscillatory stretch technique was found to be more effective in improving hamstring flexibility and perceived pain compared to static stretching technique.

Keywords: Dynamic oscillatory stretchtechnique, DOS,,Flexibility, Extensibility, Hamstring, Static stretching, Tightness.

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Introduction

Flexibility is an imperative factor for fitness, which has a significant part in functional development of musculoskeletal system and optimisation of muscle performance.[1] One of the most commonly observed causes of injuries to hamstring muscles is reduced flexibility.[2] According to literature, flexibility of a muscle is defined as the capability of a muscle to increase its length by completing a range of movement of one joint.[3] Flexibility is a biomechanical component of the tissues in the body and it determines the available range of motion (ROM) of a joint or group of joints without causing an injury.[4] Reduced flexibility is the main cause of strain injuries to hamstring muscles.[5,6] Hamstring tightness causes a marked limitation in ROM of joints and considered one of the leading factors for this limitation.[7] Hamstring tightness is very common among individuals performing physical activities.[8,9] Decreased flexibility and conformity of hamstring or quadricep muscles, imbalance between length and strength of these muscles and between right and left leg hamstrings, incomplete warm-up, bad postures, prolonged sitting, fatigue causing exertion and overstretching activities, injuries to low back region and increased tension of muscle fibres, as well as limited constancy and force-producing capability of muscles lead to imbalance in lumbo-pelvic rhythm, low back injuries and increased tension in the nervous system.[10-12]

Specialised stretching exercises are used to treat muscle-shortening and to improve muscle length.[13] The most frequently used techniques are the static stretching (SS) and proprioceptive neuromuscular facilitation (PNF) stretching techniques.[14] Dynamic oscillatory stretch (DOS) technique is a modified form of PNF which is similar to agonist contract-relax (ACR) technique. ACR is a type of PNF in which contraction of agonist muscle produces a stretching force in the muscles opposite to it. It is a mainly combined form of SS, DOS and oscillatory physiological mobilisation technique[15] Arie Michaeli etal. in 2017 conducted a randomised controlled trial(RCT) to observe the effects of DOS technique on the length of hamstring muscle, its flexibility and tolerance to pain produced by stretching of hamstring muscle, and concluded that DOS technique was more helpful than SS in order to obtain a rapid increase in length and flexibility of hamstring muscles, and that DOS established an increased threshold

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level for stretch induced even after one hour post-intervention.[15] Therefore, there is an existing interaction between stretch-contraction activities when these are both applied collectively. These techniques are helpful in providing control of oedema and soreness after vigorous exercise by maintaining better lymphatic system drainage and venous return in result of their combined effect.[16,17]

The current study was planned to find out the effects of both SS and DOS techniques in healthy individuals with markedly increased tightness of hamstring muscles.

Patients and Methods

The single-blind randomised controlled trial (RCT) was conducted from March to June 2018 at Sadiq Hospital, Sargodha Institute of Health Sciences, and District Headquarter (DHQ) Teaching Hospital, Sargodha, Pakistan, and was registered with ClinicalTrials.gov Protocol Registration and Results System number NCT03885557. After approval from the research ethics committee of Riphah International University, Islamabad, the sample size was calculated using OpenEpi3 calculator with 95% confidence interval (CI; 2 sided), power 80% and 1% ratio of the inter-group sample.[15,18] The mean difference for pain perceived as stretch tolerance was used, and since the RCT involved healthy and easily accessible individuals, the sample size was extrapolated.[15] Informed consent was taken from all individuals included in this study. The sample was raised using purposive sampling technique, and comprised young healthy individuals with hamstring tightness. All the participants were screened out on the basis of inclusion criteria (i.e. males and females with age limit 20 to 40 years , Active knee extension/90-90 test positive for Screening (With AKE range less than 160 degrees), no known history of hip joint or knee joint disease, no history of recent hamstring strain) and exclusion criteria (i.e. History of sub-acute and chronic back pain in the region and SI joint in past 6 months, neurological pathology, patients with some kind of particularly specific pathology (e.g. infection, tumour, osteoporosis, lumbar spine fracture, structural deformity, inflammatory disorder). Those selected were randomly allocated into DOS and SS groups using the sealed envelope method. Data was collected using a self-structured questionnaire related to demographic data, like age, and gender. Height and weight taken to calculate participant's body mass index (BMI) and any history of trauma was noted. Lengthwise measurement of the hamstring group of muscles was done by applying active straight leg raise (ASLR) test, active knee extension (AKE) test and the sit and reach test (SRT). ASLR and PSLR have a cut-off score of straight leg raise (SLR) or hip joint flexion with knee straight of 70^{O} and individuals with SLR $<70^{O}$ are considered to have tightness of hamstring muscles. Also, the reliability for SLR tests is >0.97.[19] For hamstring tightness, the cut-off AKE angle is 160°and those with $<160^{O}$ are considered to have hamstring tightness.[7] AKE or popliteal angle measurement test is also very reliable with a value of 0.94.[20] SRT has also shown high reliability and validity for young healthy individuals.[21]

Measurements were taken using universal goniometer and a measuring tape. Numeric pain rating scale (NPRS) was used to assess the tolerance ability of individuals for pain produced by the application of stretch techniques and it was done at the end of PSLR test. After the application of hot pack treatment of 7-10 minutes to both the groups, the DOS group had 30 repetitions each of 2-second stretch in a session. The SS groups had 2 repetitions each of 30 seconds in a session. An experienced orthopaedic manual physical therapist applied these techniques on the patients of both groups throughout the intervention period. Assessment was done at baseline, immediate post-intervention levels (10min) and post-intervention level after 1 hour.

Data was analysed using SPSS 20.1. Normality of different variables was assessed. Shapiro-Wilk test provided the basis for normality distribution of data. There was non-normal distribution of data for right leg ASLR test, PSLR test, AKE test, right leg NPRS for stretch tolerance and left leg AKE test, and left leg NPRS. For inter-group analysis of these variables, non-parametric Mann-Whitney U test was applied. On the other side, normal distribution was found for left leg ASLR test, PSLR test, right and left leg SRT, and, therefore, parametric independent sample t-test was applied for these variables.

Results

Of the 94 subjects approached, 83(88%) were included and 80(96%) of them completed the study; 40(50%) in each of the two groups (Figure). The mean age of the DOS group was 24.22±4.09 years and that of the SS group was 25.85±6.09 years. Overall, there were 13(16.2%) males and 67(83.8%) females. Mean BMI in the DOS groups was 23.05±5.09 and it was 22.54±3.93 in the SS group. In the DOS group, 27(67.5%) had dominant tightness in left leg hamstring musculature and the corresponding number in the SS group was 31(77.7%).

Immediate post-intervention (10min) scores were significantly different between the groups for various variables (Table 1).

Tolerance for stretch-induced pain for right and left leg using NPRS was significant between the groups (Table 2).

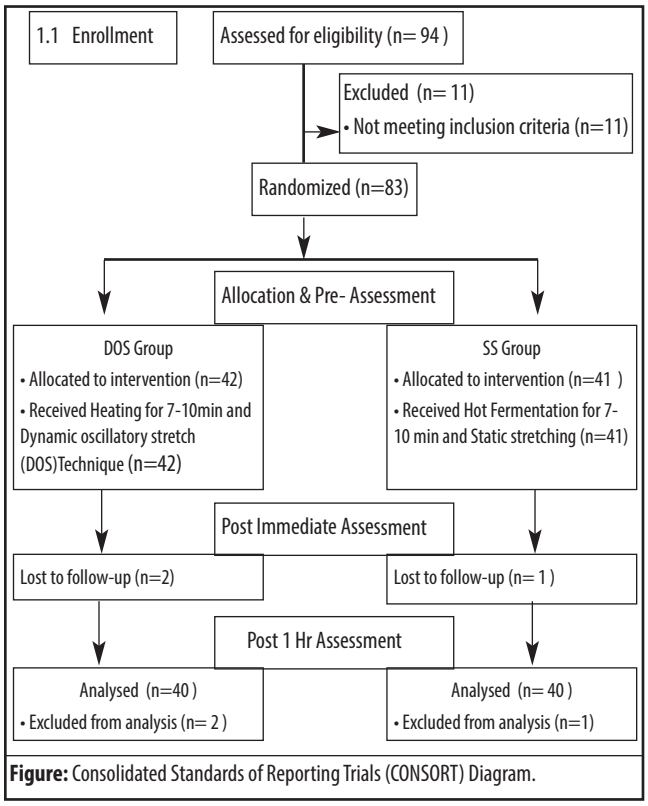

Figure: Consolidated Standards of Reporting Trials (CONSORT) Diagram.

Table-1: Inter-Group Parametric Analysis.

Variable	Sub-Variable	Groups	Mean±S.D	*p*-value
Left Leg ASLR Test	Pre	DOS Group	55.67±7.18	0.477
		SS Group	56.65±4.77	
	Post (M)	DOS Group	64.55±7.77	0.002**
		SS Group	59.90±4.67	
	Post (1 Hr.)	DOS Group	62.70±7.62	0.001**
		SS Group	58.00±4.61	
Left Leg PSLR Test	Pre	DOS Group	60.47±7.33	1.000
		SS Group	60.47±4.78	
	Post (M)	DOS Group	69.85±8.12	0.001**
		SS Group	63.3±4.37	
	Post (1 Hr.)	DOS Group	68.1±8.19	0.001**
		SS Group	61.87±4.65	
Right Leg Sit & Reach Test	Pre	DOS Group	21.40±4.43	0.382
		SS Group	20.51±4.53	
	Post (M)	DOS Group	24.05±4.61	0.071
		SS Group	22.18±4.52	
	Post (1 Hr.)	DOS Group	24.02±4.33	0.045*
		SS Group	21.99±4.56	
Left Leg Sit & Reach Test	Pre	DOS Group	21.17±5.04	0.135
		SS Group	19.63±4.04	
	Post (M)	DOS Group	23.97±4.96	0.008
		SS Group	21.22±4.109	
	Post (1 Hr.)	DOS Group	23.51±4.79	0.018*
		SS Group	21.06±4.24	

Post (M); Immediate Post intervention, Post (1hr); After 1 hour of intervention, ASLR: Active Straight Leg Raise, PSLR: Passive Straight Leg raise, * <0.05, ** <0.01 , *** < 0.001); DOS: Dynamic oscillatory stretch technique; SS: Static stretching technique; SD: Standard deviation.

Table-2: Inter-Group Non-Parametric Analysis.

Variable	Sub-Variable	Median (IQ)	Mean Rank		*p*-value
			DOS Group	SS Group	
Right Leg ASLR Test	Pre	64(7)	38.65	42.35	0.473
	Post (M)	64(8.75)	47.65	33.35	0.006**
	Post (1 hr.)	62(6)	46.80	34.20	0.015*
Right Leg PSLR Test	Pre	64(7)	41.09	39.91	0.820
	Post (M)	68(9)	49.78	31.23	0.001**
	Post (1 hr.)	66(8.75)	49.26	31.74	0.001**
Right Leg Active Knee Extension (AKE) Test	Pre	125(5)	42.40	38.60	0.456
	Post (M)	129(7.75)	53.34	27.66	0.001**
	POST (1 hr.)	128(7)	53.41	27.59	0.001**
Right Leg NPRS (Stretch Tolerance)Test	Pre	4(1)	37.36	45.39	0.164
	Post (m)	4(2)	35.61	52.43	0.047*
	Post (1 hr.)	3(1)	28.66	41.79	0.001**
Left Leg Active Knee Extension (AKE) Test	Pre	120.5(5)	39.21	43.64	0.615
	Post (m)	129(7.75	50.71	30.29	0.001**
	Post(1 hr.)	128(7)	50.24	30.76	0.001**
Left Leg NPRS (Stretch Tolerance)	Pre	3(1)	40.41	40.59	0.971
	Post (M)	2(2)	27.13	53.88	0.001**
	Post (1 hr.)	2(2)	23.03	57.98	0.001**

Post (M); Immediate Post intervention, Post (1hr); After 1 hour of intervention, ASLR (Active straight leg raise), PSLR (Passive Straight Leg raise), NPRS (Numeric Pain rating scale), * <0.05, ** <0.01 , *** < 0.001); DOS: Dynamic oscillatory stretch technique;
SS: Static stretching technique; SD: Standard deviation.

Discussion

Stretching is an interventional technique supported by literature to improve hamstring flexibility.[22] In order to improve ROMs of joints and flexibility of muscles, stretching exercises are recommended techniques and can be helpful in preventing damaging conditions of routine activities to joints and muscles.[13] There are multiple stretching techniques and SS and PNF are the commonly used ones.[14] Therefore various types of stretching interventions aimed at producing an increment in muscle flexibility are frequently described in studies.[23]

In DOS technique, the therapist raises the individual's leg where the first point of stretch sensation is felt and at the same time the stretch is assisted by contraction of hip flexor muscles of the individual and knee extensors maintain the knee extension throughout the stretch. The hold time for stretch is 2 seconds and then the therapist lowers the leg to almost 30 degrees and the process is then repeated.[15] SS is applied to stretch muscles when body is in a state of rest. The therapist passively raises the leg and gradually lengthens the muscle from the first point of stretch to the point of discomfort felt by the individual. The hold time at this point is 15 seconds until a new point for further stretch is achieved where the individual may tolerate it.[14]

In the current study, there was no difference between DOS and SS group at the baseline, but the difference was

significant after the application of stretching techniques at both immediate and 1 hour post-intervention levels, indicating that extensibility of hamstring muscles can be enhanced by the application of both SS and DOS techniques. Between the groups, DOS showed better gain in flexibility of hamstring muscles compare to the SS group at immediate and 1 hour post-intervention levels.

A study conducted by Sandeep Singh et al. in 2015 to compare the effects of PNF stretch technique and mobilisation techniques for nerves concluded that both were equally effective in producing an increment in AKE and SLR ranges, but PNF stretching alone provided better results compared to the neural mobilisation alone. The results of current study are in line with the conclusion.[24] Modified PNF stretching techniques were applied by James W Youdas et al. and they concluded that knee extension angle (KEA) range was significantly ($p<0.001$) improved by the application of both hold relax with agonist contraction (HR-AC) and HR techniques in a single PNF stretch session.[3] In the current study, a single session of DOS, which is modified PNF technique, showed a marked improvement in AKE range ($p<0.001$).

In 2017 an RCT conducted by Arie Michaeli et al. concluded that there was no marked improvement of ROMs of lower extremity in PSLR test identified in either DOS or SS groups after 1 hour of intervention.[15] Overall results of the current study found that even at 1 hour post-intervention DOS technique had relatively better effect compared to the SS group.

In 2011, a comparative study by Yutetsu Miyahara et al. found that contract relax agonist contraction (CRAC)technique showed significant ($p<0.01$) improvement in ranges compared to SS technique and this increase in range was due to improved level of pain threshold.[25] The current study concluded that DOS, which is similar to CRAC, showed marked increase in tolerance to stretch-induced pain (NPRS $p<0.001$) . The agonist contract-relax technique is applied on the basis of neuro-physiological principles in which antagonistic muscles are mechanically activated by reciprocal inhibition.[26]

David G Behm. et al. concluded that DOS and SS techniques were both equally effective ($p>0.05$) to cause an improvement in SRT test values, but DOS was more useful for working individuals.[27] In the current study, at immediate post-intervention level, non-significant ($p>0.05$) improvement was observed for SRT of right leg between DOS and SS groups, while there was a significant improvement ($p<0.05$) in results of left leg SRT which is supported by literature.[17]

A study by Hyun-Gyu Cha, et.al.in 2015 found that HR-AC technique was more useful to cause an improvement in muscle activation and in reduction of fatigability of the muscles.[28] Similar findings were observed in the current study.

The current study has its limitations. DOS technique determined the effects only on healthy individuals and its long-term continuous effects with follow-up were not monitored. Future studies should avoid these limitations.

Conclusion

DOS technique was found to be more effective in improving flexibility of hamstring muscles. Pain perceived as stretch tolerance was also largely improved by application of DOS technique compared to SS in asymptomatic healthy individuals. One hour post-intervention effects in terms of hamstring flexibility were retained in individuals receiving DOS whereas those treated with SS showed decline in retention effects.

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References

1. Fatima G, Qamar M, Ul Hassan J, Basharat A. Extended sitting can cause hamstring tightness. Saudi J Sports Med 2017; 17: 110-4.
2. Castellote-Caballero Y, Valenza MC, Puentedura EJ, Fernández-de-Las-Peñas C, Alburquerque-Sendín F. Immediate effects of neurodynamic sliding versus muscle stretching on hamstring flexibility in subjects with short hamstring syndrome. J Sports Med 2014; 2014.
3. Youdas JW, Haeflinger KM, Kreun MK, Holloway AM, Kramer CM, Hollman JH. The efficacy of two modified proprioceptive neuromuscular facilitation stretching techniques in subjects with reduced hamstring muscle length. Physiother Theory Pract 2010; 26: 240-50.
4. Gkrilias P, Tsepis E, Fousekis K. The Effects of Hamstrings' Cooling and Cryostretching on Sit and Reach Flexibility Test Performance in Healthy Young Adults. Br J Med Med Res 2017; 19: 1-11.
5. Melo LTM, dos Santos Vasconcelos R, Teles LMSA, Porto LM, Maia JA, Abdon APV. Evaluation of passive stretching in the hamstrings flexibility of who practice exercises. Int J Sports Sci 2014; 4: 67-71.
6. Sambandam CE, Alagesan J, Shah S. Immediate Effect of Muscle Energy Technique and Eccentric Training on Hamstring Tightness of Healthy Female Volunteers-A Comparative Study. Int J Curr Res Rev 2011; 3: 122-6.
7. Iwasaki R, Yokoyama G, Kawabata S, Suzuki T. Lumbar Extension during Stoop Lifting is Delayed by the Load and Hamstring Tightness. J Phys Ther Sci 2014; 26: 57-61.
8. Houston MN, Hodson VE, Adams KK, Hoch JM. The effectiveness of whole-body-vibration training in improving hamstring flexibility in physically active adults. J Sport Rehab 2015; 24: 77-82.
9. Nagarwal A, Zutshi K, Ram C, Zafar R, Hamdard J. Improvement of hamstring flexibility: A comparison between two PNF stretching techniques. Int J Sports Sci Engineering 2010; 4: 25-33.
10. Liu H, Garrett WE, Moorman CT, Yu B. Injury rate, mechanism, and risk factors of hamstring strain injuries in sports: A review of the literature. J Sport Health Sci 2012; 1: 92-101.

11. Linklater JM, Hamilton B, Carmichael J, Orchard J, Wood DG. Hamstring injuries: anatomy, imaging, and intervention. Semin Musculoskelet Radiol 2010; 14:131-61.
12. Croisier JL. Factors associated with recurrent hamstring injuries. Sports Med 2004; 34: 681-95.
13. Lim KI, Nam HC, Jung KS. Effects on hamstring muscle extensibility, muscle activity, and balance of different stretching techniques. J Phys Ther Sci 2014; 26: 209-13.
14. Ghram A, Damak M, Costa PB. Effect of acute contract-relax proprioceptive neuromuscular facilitation stretching on static balance in healthy men. Sci Sports 2017; 32: e1-7.
15. Michaeli A, Tee JC, Stewart A. Dynamic oscillatory stretching efficacy on hamstring extensibility and stretch tolerance: a randomized controlled trial. Int J Sports Phys Ther 2017; 12: 305-13.
16. Sands WA, McNeal JR, Murray SR, Ramsey MW, Sato K, Mizuguchi S, et al. Stretching and Its Effects on Recovery: A Review. Strength Conditioning J 2013; 35: 30-6.
17. Karnati VNP, Mohammed AMA. Static versus PNF stretching in hamstring flexibility-a comparative study. Int J Physiother 2015; 2: 513-7.
18. Sullivan KM, Dean A, Soe MM. On academics: OpenEpi: a web-based epidemiologic and statistical calculator for public health. Public Health Reports 2009; 124: 471-4.
19. Okamura S, Wada N, Tazawa M, Sohmiya M, Ibe Y, Shimizu T, et al. Injuries and disorders among young ice skaters: relationship with generalized joint laxity and tightness. Open Access J Sports Med 2014; 5: 191-5.
20. Kage V, Ratnam R. Immediate effect of active release technique versus mulligan bent leg raise in subjects with hamstring tightness: a randomized clinical trial. Int J Physiother Res 2014; 2: 301-4.
21. Mayorga-Vega D, Merino-Marban R, Real J, Viciana J. A physical education-based stretching program performed once a week also improves hamstring extensibility in schoolchildren: a cluster-randomized controlled trial. Nutr Hosp 2015; 32: 1715-21.
22. Nishikawa Y, Aizawa J, Kanemura N, Takahashi T, Hosomi N, Maruyama H, et al. Immediate effect of passive and active stretching on hamstrings flexibility: a single-blinded randomized control trial. J Phys Ther Sci 2015; 27: 3167-70.
23. Fletcher IM, Anness R. The acute effects of combined static and dynamic stretch protocols on fifty-meter sprint performance in track-and-field athletes. J Strength Conditioning Res 2007; 21: 784-7.
24. Singh S, Grover V, Singh S. Effect of Neural Mobilization and PNF Stretching on Hamstring Flexibility in Working Women. Int J Health Sci Res 2015; 5: 361-8.
25. Miyahara Y, Naito H, Ogura Y, Katamoto S, Aoki J. Effects of Proprioceptive Neuromuscular Facilitation Stretching and Static Stretching on Maximal Voluntary Contraction. J Strength Conditioning Res 2013; 27: 195-201.
26. Jadav M, Patel D. Comparison of effectiveness of post facilitation stretching and agonist contract-relax technique on tight hamstrings. Indian J Physical Ther 2015; 2: 70-5.
27. Behm DG, Plewe S, Grage P, Rabbani A, Beigi HT, Byrne JM, et al. Relative static stretch-induced impairments and dynamic stretch-induced enhancements are similar in young and middle-aged men. Appl Physiol Nutr Metabol 2011; 36: 790-7.
28. Cha HG, Kim M-K. Effects of the hold and relax-agonist contraction technique on recovery from delayed onset muscle soreness after exercise in healthy adults. J Phys Ther Sci 2015; 27: 3275-7.